STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

RUSSIAN RIVER SALMON SOCKEYE STUDY

by

David C. Nelson

ALASKA DEPARTMENT OF FISH AND GAME
Don W. Collinsworth, Commissioner

SPORT FISH DIVISION
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RESEARCH PROJECT SEGMENT

State: Alaska

Name: Sport Fish Investigations of Alaska

Project: F-9-17

Study: G-II

Study Title: SPORT FISH STUDIES

Job: G-II-C

Job Title: Russian River Sockeye Salmon Study

Cooperator: David C. Nelson

Period Covered: July 1, 1984 to June 30, 1985

ABSTRACT

A creel census was conducted during the 1984 Russian River sockeye salmon, *Oncorhynchus nerka* (Walbaum), sport fishery to determine harvest and angler participation in the fishery. Census data revealed 49,550 man-days of angler effort were expended to harvest 57,850 sockeye salmon. Early and late runs contributed 35,880 and 21,970 salmon, respectively, to the harvest. Sport fishermen harvested 32.2 percent of the sockeye salmon return to the upper Russian River drainage in 1984. Seasonal catch per angler hour was 0.238 or 4.2 hours fished for each salmon harvested.

The incidental harvest of rainbow trout, *Salmo gairdneri* Richardson, declined for the third consecutive year and is suggestive of a declining population. The harvest of Dolly Varden, *Salvelinus malma* (Walbaum), declined for the second consecutive year. A conclusion regarding the status of this species must be deferred until more definitive data are available. The harvests of coho salmon, *Oncorhynchus kisutch* (Walbaum), pink salmon, *Oncorhynchus gorbuscha* (Walbaum), and Arctic grayling, *Thymallus arcticus* (Pallas), approximate historic catches.

Spawning escapements of early and late run sockeye salmon which utilize the Upper Russian Lake drainage were determined by weir at the outlet of Lower Russian Lake. Early and late run spawning escapements above the weir were 28,910 and 92,660 salmon, respectively. Early run escapement exceeded the minimum escapement goal of 9,000 fish by 221.2 percent. Late run escapement exceeded the minimum escapement goal of 30,000 by 208.9 percent and was 50,115 fish above the mean historical escapement of 42,545. An additional 3,000 late run sockeye salmon spawned below the weir in lower Russian River. This is one of the lowest escapements in this area which has ranged from 220 to 45,000 late run fish, averaging 10,644.

Management of the 1984 recreational fishery is discussed, as are escapement goals for early and late runs. It is concluded that Upper Russian Lake, the only known rearing area for both early and late runs, is at or near carrying capacity. Present minimum escapement goals of 9,000 early and 30,000 late run sockeye salmon are appropriate and should be retained.

Early run Russian River sockeye salmon are harvested only by the Russian River sport fishery. Late run Russian River sockeye salmon are harvested commercially in Cook Inlet and by sport anglers in both the Kenai and Russian Rivers. Data indicate the combined exploitation rate on this stock in some years may be as high as 90 percent. The majority of the late run catch (mean of 66.1 percent) is taken by the Cook Inlet commercial fishery. It is concluded that when the exploitation rate in this fishery exceeds 72 percent, the Russian River recreational fishery will probably be closed to achieve the minimum spawning escapement goal. Due to an extended closure during the 1984 commercial fishery, the exploitation rate of Russian River fish in that fishery was estimated at 61.7 percent. A closure during the late run Russian River sport fishery was not required in 1984.

Analysis of scales collected at Lower Russian Lake weir indicated 86.7 percent of the early run was comprised of 5-year fish of age class 1.3. Age classes 2.3, 1.2 and 2.2 contributed 7.9, 4.8 and 0.6 percents, respectively. The contribution of age class 1.3 is 4.7 times the historical contribution (18.3 percent). Mean length of early run fish sampled was 588 millimeters (23.1 inches). Male to female sex ratio was 1:0.7. The late run was comprised of 47.1 percent age class 2.2, 22.7 percent age class 1.2, 15.6 percent age class 1.3, 14.2 percent age class 2.3 and 0.4 percent age class 3.2. Historically, age class 2.2 contributes 60.7 percent and age class 1.2, 13.1 percent. Reasons for the departure of the 1984 early and late run return from the historic age class composition is not known. The mean length of late run fish sampled was 546 millimeters (21.5 inches). The male to female sex ratio was 1:0.9.

Fecundity of early and late run sockeye salmon averaged 3,505 and 2,747 eggs per female, respectively. Early run fish averaged 6.0 eggs per millimeter of length and 1,380 eggs per kilogram of body weight. Late run salmon averaged 5.1 eggs per millimeter and 1,308 eggs per kilogram. These data are within the ranges of fecundity data previously reported for these stocks.

Climatological data were collected at Lower Russian Lake weir. Air and water temperatures approximated historic data. Precipitation from June 7 through September 10 was 155.5 millimeters (6.1 inches). Average weekly discharge through Russian River Falls was 242 cubic feet per second. Although this is above the historical mean, flows were best described as "moderate". Use of the fish pass at Russian River Falls was, therefore, not required in 1984.

KEY WORDS

Alaska, Kenai Peninsula, Russian River, sockeye salmon, harvest, spawning escapement, production, age structure, fecundity, escapement goals.

BACKGROUND

Russian River is a clear stream adjacent to the Sterling Highway 9.6 km (6 mi) west of the Kenai Peninsula community of Cooper Landing, and approximately 160 km (100 mi) south of Alaska's largest city, Anchorage. The stream bisects Federally managed lands. To the south, land is administered by the Kenai National Wildlife Refuge and to the north by the Chugach National Forest. A privately owned ferry at the Kenai and Russian River confluence transports anglers to the south bank. In an average year, this area (1.6 km or 1 mi) receives about 50% of all angler effort as fishermen attempt to intercept the runs prior to their entry into Russian River. The remaining effort occurs on 3.2 km (2 mi) of Russian River above the confluence of the Kenai and Russian Rivers. Figure 1 depicts the general location of Russian River and other pertinent landmarks.

Sockeye salmon sport fishing occurs from a marker 548 m (600 yds) below Russian River Falls to a marker 1,646 m (1,800 yds) below the confluence of Kenai and Russian Rivers, a distance of 4.8 km (3 mi). This area is commonly known as the "fly-fishing-only area" and, from June 1 through August 20, terminal gear is restricted to coho (streamer) flies with gap between point and shank no greater than 9.5 mm (3/8 in).

The area between a marker below the ferry crossing and a marker 640 m (700 yds) upstream on Russian River is closed to all fishing from June 1 through July 14 to provide additional protection to early run sockeye salmon which concentrate in this area prior to continuing their upstream migration (Figure 2). Sockeye salmon sport fishing does occur in the Kenai River below the "fly-fishing-only area" with conventional tackle. Harvest and effort here is minimal due to the glacial nature of the Kenai River.

Lower Russian River from its confluence with the Kenai River upstream for 3.2 km (2 mi) is of moderate gradient. Above this point the stream flows through a canyon of considerable gradient known as Russian River Falls. Sockeye salmon have been delayed and/or totally blocked by this canyon on several occasions due to a velocity barrier caused by atypically high water. Documented mortalities of both early and late run sockeye salmon were associated with this barrier in 1971 and 1977 (Nelson, 1978). In 1979, a fish pass was constructed around the falls to enable salmon to negotiate this segment of Russian River at all water levels.

Russian River sockeye salmon runs are bimodal; i.e., there are two distinct runs. Early and late run total returns have averaged 27,879

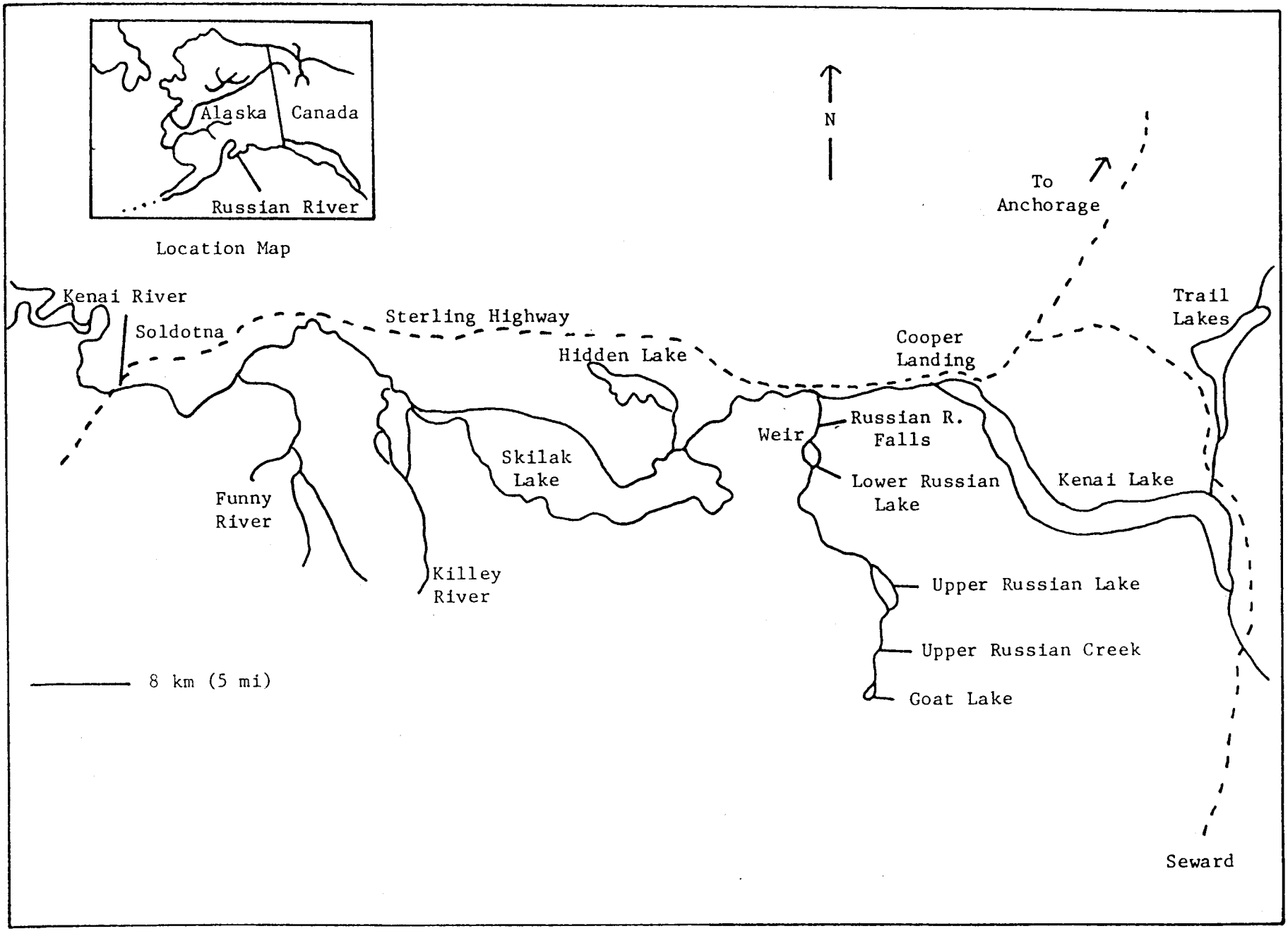

Figure 1. Schematic diagram of the Kenai River drainage.

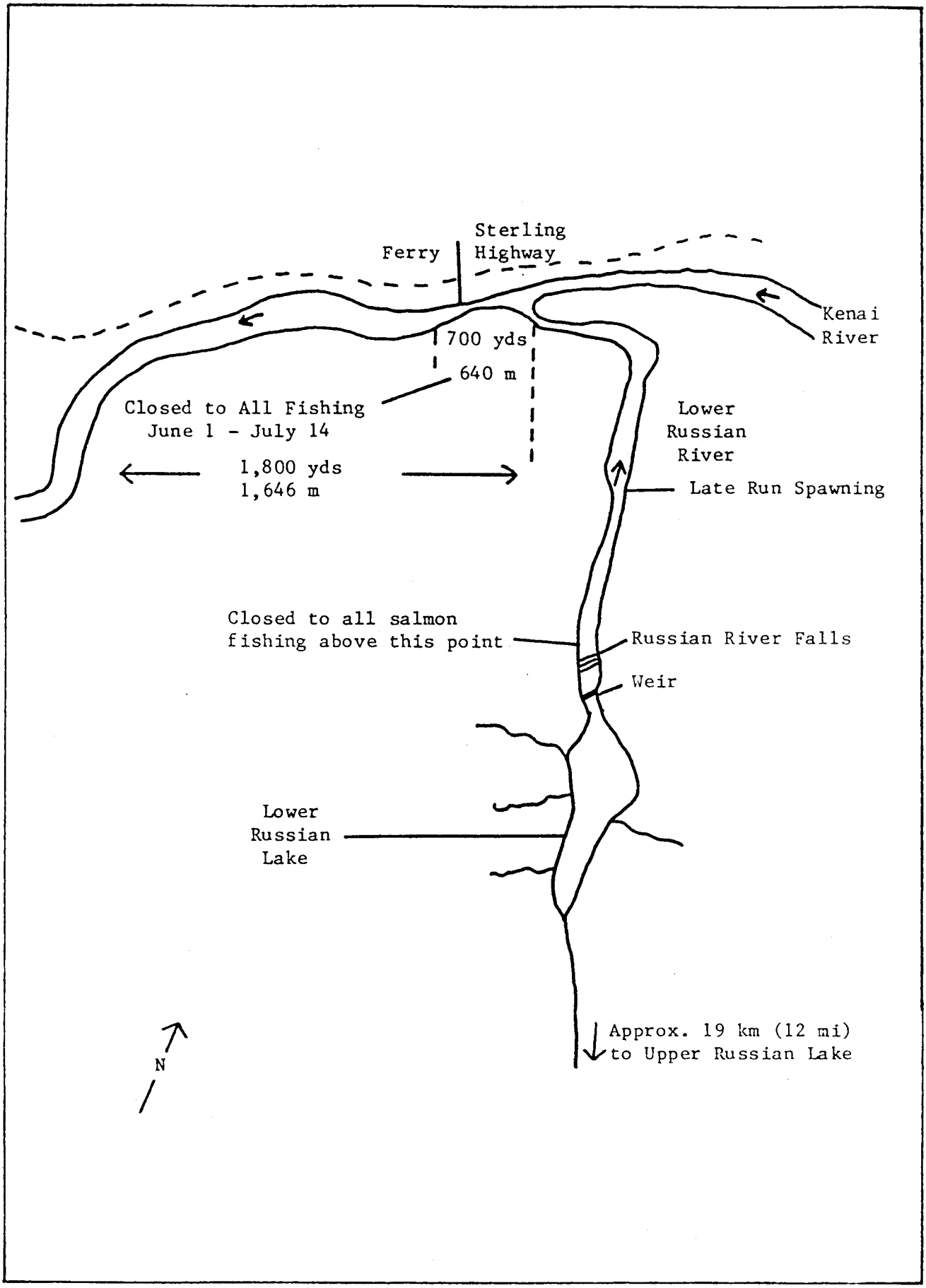

Figure 2. Schematic diagram of Lower Russian River and Kenai and Russian River confluence (not to scale).

and 54,700 fish, respectively, from 1963 through 1983. Migrational timing and entry into the fishery for these stocks have been previously presented (Nelson, 1976; 1977). Resident and anadromous fish species present in Russian River are presented in Table 1.

Lower Russian Lake, 0.8 km (0.5 mi) above Russian River Falls, supports a Dolly Varden and rainbow trout fishery. Physical characteristics of the lake have been described (Nelson, 1979). Sockeye salmon spawning in this lake is limited to less than 500 late run fish. Observation indicates Lower Russian Lake is utilized by rearing chinook and coho salmon. These species spawn in upper Russian River between Upper and Lower Russian Lakes. Coho salmon also spawn in Upper Russian Lake tributary streams.

Upper Russian River enters Lower Russian Lake from the south and connects Upper and Lower Russian Lakes. Nelson (1976) has presented a detailed description of this stream and the Upper Russian Lake drainage. Figure 3 depicts the Upper Russian Lake drainage and delineates the spawning areas of both early and late runs.

Management and research associated with the Russian River sockeye salmon sport fishery has been conducted by the Sport Fish Division of the Alaska Department of Fish and Game since 1962. Prior information pertaining to this fishery has been presented by Lawler (1963, 1964), Engel (1965-1972) and Nelson (1973-1984).

Despite a restrictive sport fishery which limits harvest methods and protects salmon in areas where they are concentrated, recreational demands upon the Russian River sockeye salmon resource has, at times, been greater than the stocks could sustain. This is evidenced in that the Sport Fish Division has closed all or part of the fishery on 19 different occasions since 1969 to increase spawning escapement levels. Numerous emergency openings and closings of the Russian River sockeye salmon fishery indicate it is the most intensely managed sport fishery in Alaska.

The Russian River program is currently directed toward "in-season" evaluation of stock status to determine the effects and effectiveness of current regulatory practices. Research activities emphasize the collection and evaluation of life history data. Objectives include determination of optimum escapement goals for both runs and ultimately predictions of sockeye salmon returns to Russian River.

RECOMMENDATIONS

1. Continue the present objectives of this study.

OBJECTIVES

1. To determine adult harvest of sport caught early and late run Russian River sockeye salmon during June, July and August in the Russian River drainage.

Table 1. A list of common names, scientific names and abbreviations of fish species found in Russian River drainage.

Common Name	Scentific Name and Author	Abbreviation
Sockeye salmon	*Oncorhynchus nerka* (Walbaum)	RS
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)	KS
Coho salmon	*Oncorhynchus kisutch* (Walbaum)	SS
Pink salmon	*Oncorhynchus gorbuscha* (Walbaum)	PS
Dolly Varden	*Salvelinus malma* (Walbaum)	DV
Rainbow trout	*Salmo gairdneri* Richardson	RT

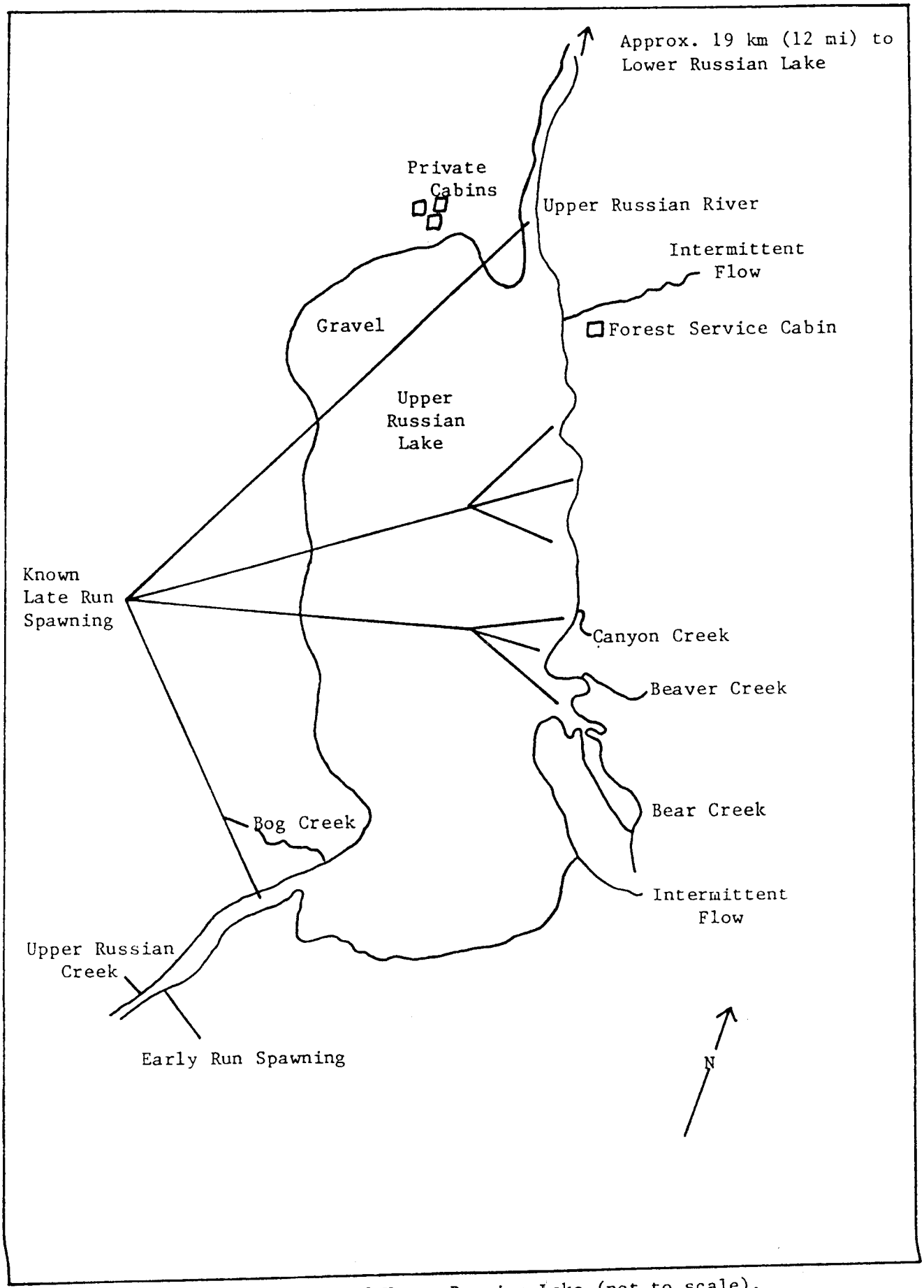

Figure 3. Schematic diagram of Upper Russian Lake (not to scale).

2. To collect and analyze biological data concerning abundance and migrational timing of adult sockeye salmon in the Russian River drainage from June to September.

3. To determine age class composition of adult early and late run Russian River sockeye salmon escapements enumerated at Lower Russian Lake weir from June to September.

4. To determine the fecundity of early and late run female sockeye salmon and to determine the relationship between fish length and mean number of eggs per sockeye salmon female.

5. To collect basic climatological data (precipitation, water and air temperature, stream discharge) during the summer at Lower Russian Lake and to determine the effect of these parameters on migrational timing of adult early and late run sockeye salmon.

6. To evaluate the effects and effectiveness of a fishpass at Russian River Falls whenever water velocity impedes sockeye salmon migration.

7. To evaluate current regulations governing this sport fishery and to provide recommendations for future management and research.

TECHNIQUES USED

The 1984 Russian River creel census was a modification of the census method described by Neuhold and Lu (1957). Sampling procedures and data analysis were identical to those outlined by Engel (1965, 1970 and 1972) and Nelson (1973, 1975). In 1984 the Russian River Falls upstream to 45.9 m (50 yds) below the weir was opened to fishing by emergency order during the early run. The census area was expanded accordingly.

Adult escapements were enumerated by weir at the outlet of Lower Russian Lake. The present structure built in June 1975 replaced an earlier temporary weir described by Engel (1970) which had been employed since 1969. Nelson (1976) has presented a detailed description of the present structure.

Fecundities of late run sockeye salmon were determined by random sampling at Lower Russian Lake weir. Sampling technique and analyses have been described (Nelson, 1981).

Scale samples to determine the age structure of the respective runs were collected at Lower Russian Lake weir. Age designation and methods to determine the adult age structure and male to female sex ratio have been presented (Nelson, 1978).

Potential egg deposition from the early run spawning escapement in Upper Russian Creek was determined applying criteria previously described (Nelson, 1976).

Water and air temperature at Lower Russian Lake weir was determined by Taylor maximum-minimum thermometer. Precipitation was ascertained by a gauge of standard manufacture. Russian River velocity was determined by Head Rod Method as previously described (Nelson, 1977). Velocity of Rondezvous Creek, tributary to Russian River above Russian River Falls, was determined in a like manner.

FINDINGS

Creel Census

As noted, Russian River sockeye salmon runs are bimodal. In some years the sport fishery is continuous, as the latter segment of the early run is present when the late run enters the fishery. This, however, did not occur from 1981-1983 (Nelson, 1983) nor in 1984. In 1984 the early run migration through the fishery was complete by July 10. The late run did not enter Russian River until July 17. No creel census was conducted from July 11 through July 16.

The census revealed anglers expended 49,550 man-days of effort during the 1984 sockeye salmon season (June 9-August 20). Effort directed toward early and late runs was estimated at 29,230 and 20,320 man-days, respectively. Angler participation in 1984 was 67.4% greater than the historical mean angler participation of 29,602 man-days. Under optimum fishing conditions, record angler effort would probably have occurred. However, as the flow rates in Russian River were "low to moderate" during both runs, salmon moved rapidly through this area which reduced fishing opportunity.

Based on interviews with 2,843 anglers who reported harvesting 3,155 sockeye salmon, total harvest was estimated at 57,850 fish. Early and later runs contributed 35,880 and 21,970 salmon, respectively, to this harvest. The 1984 catch is more than twice the mean historical catch (23,158) and is only 4,400 fish below the 1978 record harvest of 62,250. As is angler effort, catch is in part reflective of the time fish are available for harvest which was reduced in 1984 due to the rapid migration through lower Russian River.

Mean hourly catch rates were higher on weekdays (0.261) than on weekends (0.211) due to greater angler congestion on weekends which reduced individual angler efficiency. Seasonal catch per hour was 0.238 which is above the historic mean. This indicates anglers enjoyed excellent fishing conditions during both early and late runs. Table 2 summarizes historical harvest, effort and catch per hour estimates since 1963.

Total weekday and weekend stream counts during the 1984 fishery averaged 217.1 and 342.3 anglers, respectively. These counts are indicative of

Table 2. Estimated sockeye salmon harvest, effort and success rates on Russian River, 1963-1984.

Year	Harvest			Total Effort (Man-Days)	Catch/ Hour	Census Period
	Early Run	Late Run	Total			
1963	3,670	1,390	5,060	7,880	0.190	6/08-8/15
1964	3,550	2,450	6,000	5,330	0.321	6/08-8/16
1965	10,030	2,160	12,190	9,720	0.265	6/15-8/15
1966	14,950	7,290	22,240	18,280	0.242	6/15-8/15
1967	7,240	5,720	12,960	16,960	0.141	6/10-8/15
1968	6,920	5,820	12,740	17,280	0.134	6/10-8/15
1969	5,870	1,150	7,020	14,930	0.094	6/07-8/15
1970	5,750	600	6,350	10,700	0.124	6/11-8/15*
1971	2,810	10,730	13,540	15,120	0.192	6/17-8/30*
1972	5,040	16,050	21,090	25,700	0.195	6/17-8/21
1973	6,740	8,930	15,670	30,690	0.102	6/08-8/19*
1974	6,440	8,500	14,940	21,120	0.131	6/08-7/30*
1975	1,400	8,390	9,790	16,510	0.140	6/14-8/13*
1976	3,380	13,700	17,080	26,310	0.163	6/12-8/23*
1977	20,400	27,440	47,840	69,510	0.168	6/18-8/17
1978	37,720	24,530	62,250	69,860	0.203	6/07-8/09
1979	8,400	26,830	35,230	55,000	0.136	6/09-8/20*
1980	27,220	33,490	60,710	56,330	0.243	6/13-8/20
1981	10,720	23,720	34,440	51,030	0.156	6/09-8/20
1982	34,500	10,320	44,820	51,480	0.201	6/11-8/04**
1983	8,360	16,000	24,360	31,890	0.117	6/08-8/04**
Mean	11,005	12,153	23,158	29,601	0.174	
1984	35,880	21,970	57,850	49,550	0.238	6/09-8/19**

* Census period was not continuous during these years due to emergency closures required to increase spawning escapement levels.

** Census period was not continuous during these years due to negligible fishing effort after completion of the early run and prior to the arrival of the late run.

crowded conditions on both weekdays and weekends. On Saturday, June 23, at 1200 hours, 887 anglers were enumerated in the "fly-fishing-only area." Although this is less than the record 1982 count of 1,012, it is significant in that 536 of these anglers were concentrated at the confluence of the Kenai and Russian Rivers. Angler congestion in this area was extreme during both early and late run fisheries.

Sockeye salmon were available to sport anglers for 66 days in 1984. Average daily angler effort was in excess of 750 man-days. Anglers harvested an average of 876 fish daily. These data attest to the high degree of interest in the fishery and the relatively high efficiency of Russian River sockeye salmon anglers who harvested 1.2 sockeye salmon for each man-day of effort expended.

Anglers fished an average of 4.8 hours per day on weekdays and 4.7 hours on weekends (Table 3). Nelson (1983) suggested the time the average angler spent on the stream was related to run strength. When salmon were numerous anglers fished a lesser number of hours than when there were few fish available to harvest. Data from 6 years supported this observation. The 1984 early and late runs were above average. Anglers spent an above average length of time on the stream during weekdays and their fishing day on weekends was only 0.1 hours less than the historical mean. The observation that anglers fish fewer hours when salmon are numerous, therefore, appears valid as a generalization, but exceptions do occur as is evidenced by 1984 data.

Stream counts revealed 65.4 and 82.6% of anglers fished the confluence of the Kenai and Russian Rivers during the early and late run, respectively. Russian River flows were moderate during the early run and water levels continued to decrease during the late run. There was, therefore, limited "holding water" available in Russian River and both runs migrated rapidly through this section of stream. Anglers, therefore, emphasized the confluence of the Kenai and Russian Rivers during the 1984 season as fish tended to concentrate and "hold" for a period of time in this area.

Anglers harvested 55.4% of the early run stock which returned to Russian River and 19.2% of the late. The early run exploitation rate is one of the highest recorded. This is attributed to the opening of the "sanctuary" and "Falls area." The "sanctuary" was opened on June 19 which is the earliest date fishing has been permitted in this area. This is the first time since the inception of this project in 1963 that sockeye salmon fishing has been allowed in and above Russian River Falls. Opening of additional areas are, therefore, responsible for the high early run exploitation rate. The late run exploitation rate is relatively low considering the number of fish available for harvest. As noted above, the migration of this stock through Russian River was exceptionally rapid--limiting angler opportunity.

Nelson (1982) indicated angler effort would be directed toward the more numerous stock rather than toward the early or late run per se. This

Table 3. Difference between weekday and weekend fishing pressure and rates of success at Russian River, 1964-1984.

Year	Mean Angler Counts		Catch/Hour		Mean Hours Fished	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
1964	29.6	70.6	0.444	0.209	3.3	3.9
1965	31.7	78.1	0.305	0.223	4.5	5.4
1966	53.2	143.1	0.297	0.183	4.8	5.5
1967	68.9	110.5	0.171	0.100	5.3	5.4
1968	71.5	124.9	0.153	0.107	5.3	5.8
1969	64.5	111.7	0.110	0.074	4.9	5.1
1970	83.5	127.8	0.140	0.100	4.8	4.7
1971	87.9	157.2	0.194	0.189	4.8	5.3
1972	73.3	138.5	0.203	0.187	4.0	4.4
1973	147.1	195.0	0.113	0.088	4.8	5.5
1974	123.8	144.4	0.164	0.085	4.7	5.7
1975	65.0	149.6	0.145	0.136	4.5	5.1
1976	72.5	134.4	0.165	0.161	3.5	4.5
1977	201.7	438.6	0.172	0.164	3.9	4.3
1978	264.1	425.7	0.205	0.191	3.9	4.2
1979	190.6	276.8	0.158	0.117	3.8	3.9
1980	299.1	317.8	0.270	0.210	4.2	4.7
1981	195.6	238.5	0.167	0.141	4.1	4.1
1982	256.0	423.4	0.210	0.194	4.3	4.5
1983	205.1	307.6	0.208	0.151	4.6	4.6
Mean	129.2	205.7	0.200	0.151	4.4	4.8
1984	217.1	342.3	0.261	0.211	4.8	4.7

was not true in 1984. Total early and late run return to Russian River was 64,790 and 114,630 salmon, respectively. The early run provided 59.0% of the fishing opportunity and the late run 41.0% (Table 4). Although the reasons for anglers concentrating on the early as opposed to the late run are not definitely known, it is probable that the publicity received by the early run was a contributing factor. Numerous news releases regarding the opening of the "sanctuary" and "Falls area" undoubtably attracted anglers to Russian River to participate in these special openings. Publicity regarding the late run return was less extensive.

In 1977 the Division of Sport Fish initiated a Statewide Harvest Survey. It is from this survey that harvest estimates for species other than sockeye salmon are derived for Russian River (Nelson, 1982). Although harvest estimates for these species are not included as an objective of the Russian River study, the results of the survey as they relate to Russian River are summarized in Table 5 to maintain the continuity of the Division of Sport Fish's research and management efforts on this popular Alaskan stream.

Both the 1983 rainbow trout and Dolly Varden harvest were the lowest recorded. The coho salmon harvest of 1,490 compares favorably with the historic mean. The pink salmon harvest of 52 is above the previously reported harvest for this species during "odd" years but well below the 1977-1982 mean of 568. Ten Arctic grayling were reported caught in 1983. In 1984 a Fish and Game employee caught and released an Arctic grayling in lower Russian River. This is the first confirmed observation of this species in Russian River. Prior observation had revealed that these fish were caught only at the confluence.

Nelson (1983) reviewed the Russian River rainbow trout fishery from the late 1930's to present. Available information from Federal records indicated that as early as 1940 the population was beginning to decline. Under State management several restrictive regulatory actions were promulgated in an effort to restore the population to former levels. There is no information regarding this stream's rainbow trout fishery from the early 1940's until the initiation of the Statewide Harvest Survey in 1977.

The Harvest Survey revealed the catch of this species increased from 1977 through 1979 and then began to decline. A harvest of only 462 fish in 1983 represents the fourth year of decreased catches. Angler preference, water levels, availability of sockeye salmon, etc., undoubtably influence the numbers of rainbow trout harvested. However, 4 years of declining catches strongly suggest a declining population. In 1983 the Alaska Board of Fisheries recognized the possible decline exhibited by this species in Russian River. To provide additional protection to these fish, that area from the confluence of the Kenai and Russian Rivers upstream to Lower Russian Lake and the stream between Upper and Lower Russian Lake was designated a "hook-and-release" area for rainbow trout. Retention of this species during 1984 was prohibited.

Table 4. Angler effort directed toward early and late run Russian River sockeye salmon stocks, 1963-1984.

Year	Effort (Man-Days)*		Effort (Percent)	
	Early Run	Late Run	Early Run	Late Run
1963	5,710	2,170	72.5	27.5
1964	3,980	1,350	74.7	25.3
1965	7,750	1,970	79.7	20.3
1966	11,970	6,310	65.5	34.5
1967	11,460	5,500	67.6	32.4
1968	11,780	5,500	68.2	31.8
1969	12,290	2,640	82.3	17.7
1970	9,700	1,000	90.7	9.3
1971	6,250	8,870	41.3	58.7
1972	12,340	13,360	48.0	52.0
1973	15,220	15,470	49.6	50.4
1974	11,090	10,030	52.5	47.5
1975	5,210	11,300	31.5	68.5
1976	8,930	17,380	33.9	66.1
1977	38,200	31,310	55.0	45.0
1978	51,910	17,950	74.3	25.7
1979	25,670	29,330	46.7	53.3
1980	31,430	24,900	55.8	44.2
1981	24,780	26,250	48.6	51.4
1982	39,000	12,480	75.8	24.2
1983	18,560	13,330	58.2	41.8
Mean	17,297	12,305	60.6	39.4
1984	29,230	20,320	59.0	41.0

* Man-day is one angler fishing for 1 day irrespective of the number of hours fished.

Table 5. Estimated Russian River harvest of rainbow trout, Dolly Varden, coho salmon, pink salmon and grayling as determined by Alaska Statewide Harvest Survey, 1977-1983.

Year	Species				
	Rainbow Trout	Dolly Varden	Coho Salmon	Pink Salmon	Arctic Grayling
1977	769	914	1,472	37	37
1978	2,423	2,588	1,466	1,300	18
1979	3,109	3,718	1,098	0	9
1980	2,566	2,256	1,025	930	69
1981	1,437	2,905	346	0	119
1982	1,077	1,730	1,275	1,142	34
Mean	1,897	2,352	1,114	568	48
1983	462	587	1,490	52	10

Dolly Varden in Russian River are second in abundance only to sockeye salmon. The 1983 harvest of 587 is well below the mean historical catch of 2,352 and is the second consecutive year of declining catches. As with rainbow trout, variables other than population size undoubtably affect the magnitude of the catch.

A conclusion regarding the Russian River's Dolly Varden population must, therefore, be deferred until more definitive data become available.

Escapement

The weir at the outlet of Lower Russian Lake was operational June 8. The first early run sockeye salmon was passed on June 9, 8 days prior to the mean historic (1960-1983) arrival of June 17. Fifty percent of the early run was enumerated by June 25. Passage of this run was complete by July 16 (Table 6).

Early run spawning escapement was 28,910 fish. This is the ninth consecutive year the early run minimum spawning escapement goal of 9,000 has been exceeded (Table 7). Total early run return (harvest plus escapement) was 64,790.

Late run fish began to pass the weir on July 17, 2 days earlier than their average annual arrival date. Fifty percent of the spawning escapement had passed the structure by August 4. Late run migration was complete when the weir was removed on September 9.

Escapement of late run fish to the Upper Russian Lake drainage was 92,660. This is the highest escapement to pass the weir since escapement enumeration began in 1963. An additional 3,000 late run fish spawned below Russian River Falls. Total late run spawning escapement was 95,660, or 78.0% above the historic mean total escapement of 53,743.

Total late run return (harvest and total escapement) was 117,630. This closely approximates the record 1980 total return of 120,690 and exceeds the historic mean return of 68,506 by 71.7% (Table 8).

Chinook salmon escapement through the weir was 270 in 1984. An additional 120 chinook salmon spawned in lower Russian River. The total spawning escapement of 390 is, therefore, 161 fish above the historic mean escapement (229) for this species. Coho salmon escapement was 4,000 which is one of the highest escapements recorded. Russian River chinook and coho salmon escapements are summarized in Table 9.

Relationship of Jacks to Adults

Jack (precocial male) sockeye salmon are generally not associated with the early run. Prior to 1983, jacks were observed during only 5 of 12 years and then not in large numbers (Nelson, 1982). In 1983 and 1984, 98 and 10 jacks, respectively, were passed during the early run migration. Jacks are more numerous during the late run and comprise 0.2

Table 6. Arrival date, date fifty percent of the escapement had passed Russian River weir/counting tower and termination date of early and late Russian River sockeye salmon runs, 1960-1984*.

Year	Early Run			Late Run		
	Arrival at Weir/ Counting Tower	Date 50% Passed	Date Run Ended	Arrival at Weir/ Counting Tower	Date 50% Passed	Date Run Ended**
1960	June 19	June 26	July 15	July 16	Aug. 1	Aug. 12
1961	June 21	June 28	July 15	July 16	July 31	Aug. 28
1962	June 18	July 4	July 15	July 16	July 30	Aug. 31
1963	June 18	July 1	July 12	July 16	July 31	Aug. 23
1964	June 20	July 7	July 15	July 16	July 30	Aug. 15
1965	June 22	July 4	July 15	July 16	Aug. 5	Aug. 15
1966	June 20	June 29	July 15	July 19	July 30	Aug. 17
1967	June 20	June 28	July 15	July 19	Aug. 2	Aug. 18
1968	June 25	June 29	July 13	July 19	July 31	Aug. 14
1969	...	...	...	July 16	Aug. 2	Aug. 18
1970	June 17	July 5	July 15	July 16	Aug. 7	Aug. 23
1972	June 24	July 5	July 29	July 30	Aug. 5	Aug. 28
1973	June 21	July 6	July 15	July 16	Aug. 1	Aug. 30
1974	June 14	July 1	July 21	July 22	Aug. 7	Aug. 27
1975	June 25	July 6	July 27	July 21	Aug. 6	Sept. 1
1976	June 17	June 30	July 16	July 17	Aug. 2	Sept. 1
1978	June 10	July 2	July 24	July 2	July 30	Sept. 1
1979	June 8	June 27	July 15	July 16	July 29	Sept. 2
1980	June 14	June 29	July 20	July 21	July 30	Sept. 6
1981	June 12	June 25	July 17	July 18	July 28	Sept. 6
1982	June 11	July 3	July 23	July 24	Aug. 4	Sept. 14
1983	June 12	July 1	July 25	July 26	Aug. 6	Sept. 6
1960-83 Mean	June 17	July 1	July 18	July 18	Aug. 2	Aug. 26

Table 6 (cont.). Arrival date, date fifty percent of the escapement had passed Russian River weir/counting tower and termination date of early and late Russian River sockeye salmon runs, 1960-1984*.

	Early Run			Late Run		
Year	Arrival at Weir/ Counting Tower	Date 50% Passed	Date Run Ended	Arrival at Weir/ Counting Tower	Date 50% Passed	Date Run Ended**
1969-1983 Mean***	June 15	July 1	July 20	July 19	Aug. 2	Sept. 1
1984	June 9	June 25	July 16	July 17	Aug. 4	Sept. 9

* Data from 1971 and 1977 deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.
** Date run ended or escapement enumeration discontinued for the season.
*** Years of weir operation.

Table 7. Russian River sockeye salmon escapement and harvest rates for early and late runs, 1963-1984.

Year	Escapement*			Percentage of Run Caught by the Sport Fishery		
	Early Run	Late Run	Total	Early Run	Late Run	Total
1963	14,380	51,120	65,500	20.3	2.0	7.2
1964	12,700	46,930	59,630	21.8	5.0	9.6
1965	21,710	21,820	43,530	31.8	9.0	21.6
1966	16,660	34,430	51,090	47.3	17.5	30.3
1967	13,710	49,480	63,190	34.6	10.3	17.0
1968	9,200	48,880	58,080	42.9	10.6	18.0
1969	5,000	28,920	33,920	54.0	3.8	17.1
1970	5,450	28,200	33,650	51.3	2.1	15.9
1971	2,650	54,430	57,080	51.5	16.4	19.2
1972	9,270	79,000	88,270	35.2	16.8	19.3
1973	13,120	24,970	38,090	33.9	26.3	29.1
1974	13,150	24,650	37,800	32.9	25.6	28.3
1975	5,640	31,970	37,610	19.9	20.8	20.7
1976	14,700	31,950	46,650	18.7	30.0	26.8
1977	16,070	21,410	37,480	55.9	56.2	56.1
1978	34,150	34,230	68,380	52.5	41.7	47.7
1979	19,700	87,920	107,620	29.9	23.4	24.7
1980	28,670	83,980	112,650	48.7	29.7	35.0
1981	21,140	44,530	65,670	33.6	34.7	34.4
1982	56,080	30,630	86,710	38.1	25.2	34.1
1983	21,200	34,000	55,200	28.3	32.0	30.6
Mean	16,874	42,545	59,419	37.3	20.9	25.8
1984	28,910	92,660	121,570	55.4	19.2	32.2

* Escapement past weir. Commercial harvest and fish spawning downstream from Russian River weir are deleted.

Table 8. Late run Russian River sockeye salmon total return and escapement enumerated above and below Russian River Falls, 1968-1984.

Year	Escapement Above Falls	Escapement Below Falls	Total Escapement	Percent of Escapement Below Falls	Sport Harvest	Total Return
1968	48,800	4,200	53,000	7.9	5,820	58,820
1969	28,920	1,100	30,020	3.7	1,150	31,170
1970	28,200	220	28,420	0.8	600	29,020
1971	54,430	10,000	64,430	15.5	10,730	75,160
1972	79,000	6,000	85,000	7.1	16,050	101,050
1973	24,970	6,690	31,660	21.1	8,930	40,590
1974	24,650	2,210	26,860	8.2	8,500	35,360
1975	31,970	690	32,660	2.1	8,390	41,050
1976	31,950	3,470	35,420	9.8	13,700	49,120
1977	21,410	17,090	38,500	44.4	27,440	65,940
1978	34,230	18,330	52,560	34.9	24,530	77,090
1979	87,920	3,920	91,840	4.3	26,830	118,670
1980	83,980	3,220	87,200	4.0	33,490	120,690
1981	44,530	4,160	48,690	8.5	23,720	72,410
1982	30,630	45,000	75,630	59.5	10,320	85,950
1983	34,000	44,000	78,000	56.4	16,000	94,000
Mean	43,099	10,644	53,743	18.0	14,763	68,506
1984	92,660	3,000	95,660	3.1	21,970	117,630

Table 9. Estimated coho and chinook salmon spawning escapements in Russian River drainage, 1953-1984.

Year	Weir/Counting Tower Escapements		Lower River Escapement*	Total Escapement	
	Chinook	Coho	Chinook	Chinook	Coho
1953			85**		
1954			87**		
1955			42**		
1956			40**		
1957			44**		
1958			98**		
1966			182		
1967			126		
1968	56		63	119	
1969	119	70	31	150	70
1970	240	957	125	365	957
1971	21	839	149	170	839
1972	172	666	108	280	666
1973	243	200	104	347	200
1974	124	1,508	59	183	1,508
1975	102	4,000	32	134	4,000
1976	145	1,791	155	300	1,791
1977	37	1,884	145	182	1,884
1978	253	1,570	165	418	1,570
1979	280	2,400	82	362	2,400
1980	185	3,189	65	250	3,189
1981	30	4,679	91	121	4,679
1982	68	2,291	35	103	2,291
1983	52	475	130	182	475
Mean	133	1,768	93	229	1,768
1984	270	4,000	120	390	4,000

* Coho salmon do not spawn in lower Russian River.
** U.S. Fish and Wildlife Service data.

to 8.8% of the total late run escapement. In 1984, 3,450 jacks were enumerated comprising 3.0% of the total late run escapement to Upper Russian Lake drainage (Table 10).

Nelson (1977) suggested a relationship may exist between numbers of jacks in the late run and the magnitude of the late run return to Russian River the succeeding year. The author (Nelson, 1982) concluded a relatively small jack return in a given year may be indicative of a less than average return the following year and that the converse may also be true. Historical data indicate this premise was true as a generalization but that exceptions do occur.

Jack escapements in 1981 and 1982 were both above average. The adult returns to Russian River in 1982 and 1983 were below average. These data invalidated the previously correct premise that numbers of jacks in the preceding year are an annual indicator of run strength to Russian River. However, the premise remains valid when Russian River's contribution to the Cook Inlet commercial fishery is considered.

The number of fishing periods allocated to the Cook Inlet commercial fishery is dependent on total numbers of sockeye salmon returning to upper Cook Inlet. In 1982 and 1983 additional fishing time was permitted because the return to the area was high. The commercial harvest of Russian River fish was, therefore, above average leaving few fish to return to their natal stream. During years of low sockeye salmon returns to upper Cook Inlet, commercial fishing time is reduced. This may result in a relatively low commercial harvest of Russian River fish and correspondingly an above average return to Russian River. Jacks are not affected by the commercial fishery as they pass through the gill nets designed to capture larger adults (Nelson, 1982).

Total production (commercial harvest plus total return to Russian River) in 1982 and 1983 was above average. The preceding year's jack escapements were also above average. The 1983 jack escapement of 4,360 fish was the highest recorded. Total production in 1984 was above the historical mean. Data to date, therefore, indicate that the jack escapement the preceding year is an annual indicator of total Russian River (commercial harvest plus Russian River return) production. It is not always a definitive indicator of the return to Russian River as the percent of the run harvested commercially is subject to annual variation.

Table 11 compares the migrational timing of late run adults to jacks. Fifty percent of the adult escapement historically passes the weir by August 2, while 50% of the jack escapement is not enumerated until August 15, 13 days later than the adults. In 1984 the timing disparity was 7 days.

This timing differential may be a genetic trait, related to environmental parameters or a combination thereof (Nelson, 1976). The author indicated water velocities through Russian River Falls usually decrease during the latter part of the late run migration and may facilitate the

Table 10. Late run Russian River sockeye salmon harvest, escapement and returning jacks, 1969-1984.

Year	Escapement	Harvest	Total Return*	Number of Jacks	Percent of Total Return
1969	28,920	1,150	30,070	352	1.2
1970	28,200	600	28,800	2,542	8.8
1971	54,430	10,730	65,160**	1,429	2.2
1972	79,000	16,050	95,050	160	0.2
1973	24,970	8,930	33,900	332	1.0
1974	24,650	8,500	33,150	1,008	3.0
1975	31,970	8,390	40,360	1,788	4.4
1976	31,950	13,700	45,650	1,204	2.6
1977	21,410	27,440	48,850	537	1.1
1978	34,230	24,530	58,760	2,874	4.9
1979	87,920	26,830	114,750	1,476	1.3
1980	83,980	33,490	117,470	1,533	1.3
1981	44,530	23,720	68,250	2,634	3.9
1982	30,630	10,320	40,950	1,777	4.3
1983	34,000	16,000	50,000	4,360	8.7
Mean	42,719	15,359	58,078	1,600	3.3
1984	92,660	21,970	114,630	3,450	3.0

* Excludes commercial harvest and late run sockeye salmon which spawn below Russian River Falls.

** Excludes an estimated 10,000 late run sockeye salmon which perished below Russian River Falls due to a velocity barrier.

Table 11. Migrational timing of the late run Russian River sockeye salmon jack escapement compared to the migrational timing of the adult escapement, 1970-1984*.

Year	Jack Escapement	Date 50% Passed Weir	Adult Escapement**	Date 50% Passed Weir	Timing Differential (Days)
1970	2,542	Aug. 10	25,658	Aug. 7	3
1972	160	Aug. 10	78,840	Aug. 4	6
1973	332	Aug. 6	24,638	July 31	6
1974	1,008	Aug. 12	23,642	Aug. 6	6
1975	1,788	Aug. 16	30,182	Aug. 5	11
1976	1,204	Aug. 18	30,746	Aug. 2	16
1978	2,874	Aug. 18	31,356	Aug. 2	16
1979	1,476	Aug. 15	86,444	July 29	17
1980	1,533	Aug. 19	82,447	July 30	20
1981	2,634	Aug. 22	41,896	July 28	25
1982	1,777	Aug. 19	28,853	Aug. 4	15
1983	4,360	Aug. 16	29,640	Aug. 5	11
Mean	1,807	Aug. 15	42,862	Aug. 2	13
1984	3,450	Aug. 11	89,210	Aug. 4	7

* Data from 1971 and 1977 deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Escapement past the weir only. Sockeye salmon spawning below Russian River Falls are not considered.

movement of smaller jacks through the falls. Larger adults may be more readily capable of negotiating the falls at greater velocities and, therefore, arrive earlier at the weir. Russian River was atypically high in 1980 and 1981 which may account for the above average timing differential in those years. Water velocities were not excessive from 1982 through 1984. The timing differential of 15 days in 1982 approximated the mean, while the 11- and 7-day differential in 1983 and 1984, respectively, is what might be expected considering the reduced velocity.

Migrational Rates in the Kenai River

Migrational rates of Russian River stocks within the Kenai River are limited to isolated tagging studies and a comparison of sonar counts to escapements enumerated at Russian River weir. Tagging studies have been reviewed (Nelson, 1977).

A sonar counter is located 1.6 km (1 mi) below the Kenai River Bridge in Soldotna. This enumeration device is operated by the Commercial Fish Division of the Alaska Department of Fish and Game. Its primary function is to ascertain the spawning escapement of late run Kenai River sockeye salmon, but it was employed in 1978, 1979 and 1981 to determine the magnitude of the early run Kenai River sockeye salmon return. Available data indicate this stock is of Russian River origin. Comparing sonar counts to weir escapement data, Nelson (1982) concluded early run Russian River fish migrated 3.2 km (2 mi) to 5.1 km (3.2 mi) per day.

Late run sockeye salmon sonar counts in the Kenai River, Russian River late run escapements and travel time between sonar counter and Russian River weir are presented in Table 12. Elapsed time between these two points from 1969-1983 ranged from 10 to 34 days, averaging 14.9. Eliminating the 1969 and 1974 extremes, which appear to be atypical, decreases this range to between 10 and 18 days. The late run migrational rate would, therefore, be 5.2 km (3.2 mi) to 9.3 km (5.8 mi) per day. It required 15 days for late run fish in 1984 to traverse the 93.5 km (58 mi) between sonar site and weir or 6.2 km (3.8 mi) per day. In most years late run fish, therefore, migrate more rapidly through the Kenai River than do early run fish. Reasons for these differing migrational rates are not known.

In 1984 the Commercial Fish Division tagged late run sockeye salmon at the Kenai River sonar site to determine travel times and spawner distribution. Twenty percent (19) of the recovered tags were from Russian River weir. Travel times ranged from 10 to 37 days, averaging 20. That the travel time as determined from the tag and recovery program was greater than the travel time determined by comparing sonar to weir counts is to be expected. Tagging undoubtably placed additional stress on these fish and reduced their migrational rate.

A comparison of sonar data to total late run Russian River return (harvest plus escapement) provides an estimate of Russian River's

Table 12. Kenai River sockeye salmon sonar counts compared to Russian River late run sockeye salmon escapements and period of travel between sonar site and Russian River weir, 1968-1984*.

Year	Sonar Count	Date 50% Passed	Russian River Escapement**	Date 50% Passed	Sonar to Weir (Days)
1968	88,000	July 19	48,800	July 30	11
1969	53,000	June 30	28,920	Aug. 2	34
1970	73,000	July 25	28,200	Aug. 6	13
1972	318,000	July 24	79,000	Aug. 4	12
1973	367,000	July 22	24,970	July 31	10
1974	161,000	July 17	24,650	Aug. 6	23
1975	142,000	July 24	31,970	Aug. 5	13
1976	380,000	July 20	31,950	Aug. 2	13
1978	398,900	July 18	34,230	July 30	12
1979	285,020	July 19	87,920	July 29	10
1980	464,040	July 19	83,980	July 30	11
1981	407,640	July 14	44,530	July 28	14
1982	619,830	July 21	30,630	Aug. 4	15
1983	630,340	July 19	34,000	Aug. 6	18
Mean	313,412	July 19	43,839	Aug. 2	14.9
1984	344,570	July 21	92,660	Aug. 4	15

* Data from 1971 and 1977 deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Escapement past the weir only. Sockeye salmon spawning below Russian River Falls are not considered.

contribution to the Kenai River sockeye salmon escapement. This contribution historically ranges from 9.3 to 66.8%. In 1984, Russian River accounted for 34.1% of the late run Kenai River sockeye salmon escapement (Table 13). Spawner distribution in 1984, therefore, approximated the 1979 parent year spawner distribution when the Russian River received 41.6% of the fish that returned to the Kenai River drainage.

Russian River Falls and Fish Pass

The fish pass at Russian River Falls was constructed during the winter of 1978-1979 and employed for the first time on a limited basis during the 1979 season. At that time Nelson (1980) concluded that given an option at normal water flows, sockeye salmon would ascend the falls rather than utilizing the fish pass. During high water in 1980, migrational rate through the structure was 510 fish/hour (Nelson, 1981). The author also indicated operation or inoperation of the facility during high water years could be used to increase or decrease the rate of migration. During these times the fish pass would be utilized as a management tool, as the migrational rate of the stocks affect the degree to which the recreational angler is capable of exploiting the resource.

Figure 4 indicates Russian River discharge was above historic flow rates during both the early and late run migrations. Discharge, however, was still considered "moderate" to "low" as it never exceeded 400 cfs. Nelson (1978) indicated velocities which approximate 400 cfs present a barrier to or decrease the migrational rate. As this discharge was not achieved in 1984, Russian River Falls did not impede sockeye salmon migration nor was the fish pass of value in controlling migrational rates.

Management of the 1984 Fishery

Early Run:

The early run arrived at the confluence of the Kenai and Russian Rivers in harvestable numbers on June 9. Catch rates were initially low, but increased rapidly exceeding 0.30 fish/hour on June 15. Observation revealed the majority of the harvest and angler effort was concentrated at the confluence. The "sanctuary" contained a large number of early run sockeye salmon as did Russian River Falls. Few fish were in lower Russian River, indicating a rapid migrational rate through this area.

On June 18, escapement through Russian River weir was 1,379 salmon. Historically, only 1.8% of the escapement or 162 fish would have passed the weir by this date. In view of this high escapement, the presence of large numbers of fish in the falls and "sanctuary", and the high catch rates recorded at the confluence, the 640-m (700-yd) "sanctuary" was opened to fishing at 1200 hours on June 19.

By June 27, the spawning escapement was 17,890 fish, almost twice the minimum goal of 9,000. Catch rates were declining at the confluence indicating the majority of the run had passed through this area.

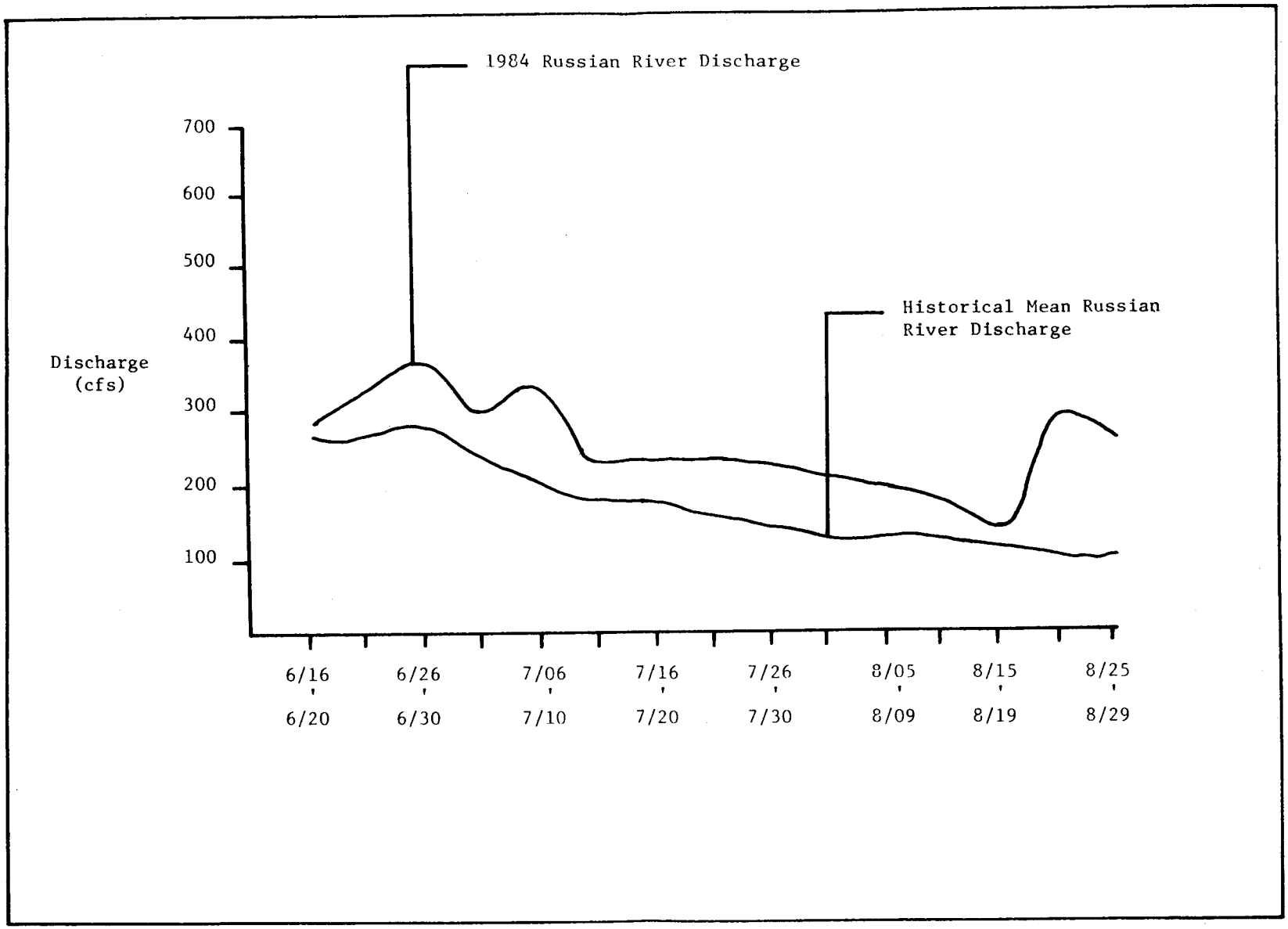

Figure 4. Mean (8 Year) Russian River discharge rates by 5 day mean recorded by United States Geological Survey from 1947 through 1954 compared to 1984 discharge rates.

Table 13. Kenai River sockeye salmon sonar counts, total late run Russian River sockeye salmon return and percent of the Kenai River late run sockeye salmon escapement to enter Russian River, 1968-1984*.

Year	Sockeye Salmon Sonar Count	Total Late Run Russian River Return**	Percent Kenai Run To Russian River
1968	88,000	58,820	66.8
1969	53,000	31,170	58.8
1970	73,000	29,020	39.7
1972	318,000	101,050	31.8
1973	367,000	40,590	11.1
1974	161,000	35,360	22.0
1975	142,000	41,050	28.9
1976	380,000	49,120	12.9
1977	708,000	65,940	9.3
1978	398,900	77,090	19.3
1979	285,020	118,670	41.6
1980	464,040	120,690	26.0
1981	407,640	72,410	17.8
1982	619,830	85,950	13.9
1983	630,340	94,000	14.9
Mean	339,718	68,062	27.6
1984	344,570	117,630	34.1

* Sonar data from 1971 deleted due to equipment malfunction.
** Total late run Russian River return includes escapement past weir, sport harvest and fish spawning below Russian River Falls.

Because of the relatively low flow rates, few fish were available to anglers in lower Russian River. Large numbers of salmon were available in the falls and, because the escapement goal was exceeded, the area of Russian River Falls upstream to a marker 45.7 m (50 yd) below the weir was opened to fishing at 1200 hours on June 28. This area again closed to the taking of salmon on July 10 after the run had negotiated the falls and passed through to the Upper Russian Lake spawning grounds.

Because of the aforementioned management strategies and the magnitude of the early run return, anglers enjoyed excellent fishing conditions. Early run catch/hour was 0.238 or one fish harvested for every 4.2 hours fished. The opening of the Russian River Falls area provided an additional 2,640 man-days of fishing opportunity which yielded 4,380 early run fish. The early run migration ended on July 10 and there were virtually no sockeye salmon present in the lower Russian River or at the confluence until the arrival of the late run on July 18.

Late Run:

Catch rates during this fishery were initially low, but steadily increased to 0.43 fish/hour (one fish every 2.4 hours) on July 29. As with the early run, the majority of the harvest and angler effort occurred at the confluence and few fish were available in lower Russian River. Due to minimal rainfall in the area, this condition persisted until the scheduled closure of the fishery on August 20.

Late run spawning escapement was 92,660 fish and the minimum escapement goal of 30,000 was achieved by August 1. Although the total escapement was more than 3 times the minimum goal, the Russian River Falls area was not opened to fishing as it was during the early run. The stream between the falls and weir had been opened during the late run in 1979 (Nelson, 1980).

Observation at that time indicated anglers were not willing to walk approximately 3.2 km (2 mi) to this area when salmon were available in more readily accessible sections of the stream. Because fishing was "good" to "excellent" at the confluence until the close of the fishery, opening this additional area would not have significantly increased recreational opportunity or harvest.

The near-record return (117,630) of late run Russian River sockeye salmon in 1984 is partially attributed to strategies employed to manage both the Cook Inlet commercial and Kenai River sockeye salmon fisheries. Stock separation data in the commercial fishery and low escapement past the Kenai River sonar counter indicated a below average return of Kenai River fish. This necessitated an extended closure beginning July 19 in the commercial fishery followed by the closure of the Kenai River sockeye salmon fishery on July 26. This reduced the exploitation of Russian River sockeye salmon, permitting a greater than average number to return to their natal stream.

Escapement Goals and Management Concerns

Escapement goals for Russian River stocks were not established until the early 1970's. These goals were adopted as a regulation by the Alaska Board of Fisheries entitled "5 AAC 21.361 RUSSIAN RIVER SOCKEYE SALMON MANAGEMENT PLAN." Early and late run minimum escapement goals established were 9,000 and 30,000 fish, respectively.

Early Run Escapement Goal:

The minimum early run escapement goal was established by analysis of the spawning area available and historic escapement levels. There was close agreement between these two methods (Nelson, 1984). At the present time the best evaluation of this escapement goal is a comparison of return per spawner from various escapement levels.

Production figures are available for the early run for parent escapements ranging from 2,640 to 34,150. Return per spawner has ranged from 0.2 to 10.6. Data further suggest this variability is independent of the numbers of fish in the spawning escapement and is probably related to conditions which are present at the time of spawning. Early run production is in large part believed to be "spawning area limited" (Nelson, 1984).

Although a positive correlation between escapement levels and return per spawner has not been demonstrated, a general trend is suggested. In the 2 years when the parent year escapement exceeded 20,000, the run failed to reproduce itself. Two years' data are not definitive, but do suggest the desired escapement level for this stock is less than 20,000 fish. From 1979-1984 early run escapements ranged from 19,700 to 56,080, averaging 29,283. If the escapements from this cycle yield a low return per spawner, it will indicate "more is not necessarily better" when "more" refers to early run escapement levels.

Conversely, escapements of less than 5,000 early run fish would have to produce a return per spawner of at least 5:1 if sufficient early run sockeye salmon are to be available for the recreational fishery. Although this return rate has occurred, the mean early run return per spawner is a relatively low 2.9:1. The minimum escapement goal of 9,000 early run fish, therefore, appears appropriate based on data currently available.

Late Run Escapement Goal:

The minimum late run spawning escapement goal was established in 1975. At this time biological data regarding this stock's early life history were limited and the contribution of this component to the commercial fishery was not known. These fish spawned primarily in Upper Russian Lake and freshwater production was, therefore, assumed to be "rearing area limited." Analysis of prior escapements suggested a minimum escapement goal of 30,000 was reasonable with an escapement approximating the historic mean escapement (40,370) being desirable (Nelson, 1984).

Commercial Harvest, Exploitation Rates and Production:

Because of the timing of the early Russian River run and the July opening of the commercial fishery harvest of this stock by the commercial fishery is negligible. Late run Russian River salmon pass through Cook Inlet from July through early August and are, therefore, commercially harvested. Stock separation techniques coupled with prior tagging programs now permit an evaluation of this stock's contribution to that fishery (Nelson, 1984). Harvests of late run Russian River sockeye salmon by both the sport and commercial fisheries are presented in Table 14.

The commercial harvest of late run Russian River fish ranges from 43,850 (1973) to 312,320 (1983) with a 1972-1983 mean of 135,193. The sport harvest at Russian River during this same period ranged from 8,390 in 1975 to 27,440 in 1977, averaging 18,158. Historically, the commercial fishery harvests 86.6% of the total catch and the sport fishery 13.4%. The commercial and sport harvests in 1984 were 184,910 and 21,970 fish, respectively. The commercial catch represented 89.4% of the total harvest and the sport catch 10.6%. The commercial fishery, therefore, accounts for the majority of the late run harvested in any given year.

Historically, the commercial fishery harvests an average of 66.1% of the late run Russian River sockeye salmon total return and the sport fishery 10.0% for a combined mean annual exploitation rate of 76.1%. From 1972 through 1983 this exploitation rate has ranged from 63.1 to 90.6%. The combined exploitation rate in 1984 was 69.1% (Table 15). This relatively low exploitation rate reflects:

1. An abbreviated season permitted the commercial fishery;

2. The large return to Russian River which was beyond the capability of the recreational fishery to harvest.

Nelson (1984) concluded the exploitation rate of late run Russian River fish will always be greater than the exploitation rate for Kenai River sockeye salmon. The Kenai River component is harvested only by the commercial fishery and a relatively minor sport fishery in the Kenai River.

Russian River salmon are also subject to these fisheries and at Russian River are exploited by the most intense sport fishery in Alaska. The 1984 exploitation rate for Kenai and Russian River salmon was 69.2 and 76.1%, respectively. This disparity may be as high as 17.3% as occurred in 1977 (Table 16).

The return per spawning fish for Kenai and late run Russian River stocks is about twice the return experienced by the Russian River early run (Table 17). This is to be expected, as the early run Russian River fish utilize the "spawning area limited" waters of Upper Russian Creek. This area is believed to provide a much more harsh and unstable spawning and

Table 14. Harvest of late run Russian River sockeye salmon stocks by commercial and recreational fisheries, 1972-1984.

Year	Commercial Harvest	Sport Harvest	Total Harvest	Percent of Harvest by Commercial Fishery	Percent of Harvest by Sport Fishery
1972	144,370	16,050	160,420	90.0	10.0
1973	43,850	8,930	52,780	83.1	16.9
1974	54,320	8,500	62,820	86.5	13.5
1975	89,410	8,390	97,800	91.4	8.6
1976	107,020	13,700	120,720	88.7	11.3
1977	88,750	27,440	116,190	76.4	23.6
1978	267,680	24,530	292,210	91.6	8.4
1979	123,320	26,830	150,150	82.1	17.9
1980	128,800	33,490	162,290	79.4	20.6
1981	96,600	23,720	120,320	80.3	19.7
1982*	165,870	10,320	176,190	94.1	5.9
1983*	312,320	16,000	328,320	95.1	4.9
Mean	135,193	18,158	153,351	86.6	13.4
1984*	184,910	21,970	206,880	89.4	10.6

* Data for these years are preliminary.

Table 15. Percentage of late run Russian River sockeye salmon harvested by commercial and sport fisheries, 1972-1984.

Year	Commercial and Sport Harvest	Escapement	Total Return	Percent Harvested		Combined Percent Harvested
				Commercial Fishery	Sport Fishery	
1972	160,420	79,000	239,420	60.3	6.7	67.0
1973	52,780	24,970	77,750	56.4	11.5	67.9
1974	62,820	24,650	87,470	62.1	9.7	71.8
1975	97,800	31,970	129,770	68.9	6.5	75.4
1976	120,720	31,950	152,670	70.1	9.0	79.1
1977	116,190	21,410	137,600	64.5	19.9	84.4
1978	292,210	34,230	326,440	82.0	7.5	89.5
1979	150,150	87,920	238,070	51.8	11.3	63.1
1980	162,290	83,980	246,270	52.3	13.6	65.9
1981	120,320	44,530	164,850	58.6	14.4	73.0
1982*	176,190	30,630	206,820	80.2	5.0	85.2
1983*	328,320	34,000	362,320	86.2	4.4	90.6
Mean	153,351	44,103	197,454	66.1	10.0	76.1
1984*	206,880	92,660	299,540	61.7	7.4	69.1

* Data for these years are preliminary.

Table 16. Exploitation rate of late run Kenai and Russian River sockeye salmon, 1972-1984.

Year	Total Return*		Commercial and Sport Harvest		Exploitation Rate	
	Kenai R.	Russian R.	Kenai R.**	Russian R.	Kenai R.	Russian R.
1972	800,070	239,420	498,100	160,420	62.3	67.0
1973	841,910	77,750	483,800	52,780	57.5	67.9
1974	433,180	87,470	288,710	62,820	66.6	71.8
1975	462,490	129,770	333,990	97,800	72.2	75.4
1976	1,287,820	152,670	934,040	120,720	72.6	79.1
1977	2,014,820	137,600	1,351,190	116,190	67.1	84.4
1978	2,272,280	326,440	1,922,350	292,210	84.6	89.5
1979	607,150	238,070	361,010	150,150	59.5	63.1
1980	993,520	246,270	581,610	162,290	58.5	65.9
1981	999,260	164,850	629,320	120,320	63.0	73.0
1982***	3,125,360	206,820	2,505,530	176,190	80.2	85.2
1983***	4,566,090	362,320	3,935,830	328,320	86.2	90.6
Mean	1,533,664	197,454	1,152,123	153,351	69.2	76.1
1984***	900,000	299,540	559,222	206,880	62.1	69.1

* Combined commercial harvest, sport harvest and spawning escapement.
** Includes the estimated sport harvest, personal use harvest, etc., which was taken below the sonar counter.
*** Data for these years are preliminary.

Table 17. A comparison of early run Russian River, late run Russian River and late run Kenai River sockeye salmon return per spawner, 1969-1979.

Brood Year	Return Per Spawner		
	Kenai River	Early Run Russian River	Late Run Russian River
1969	7.7	2.9	3.2
1970	7.2	2.3	4.7
1971	3.4	4.1	2.3
1972	7.2	10.6	3.1
1973	6.4	1.9	9.6
1974	4.2	4.0	9.8
1975	6.3	2.8	6.2
1976	3.3	7.7	8.1
1977	5.0	1.1	6.7
1978	11.1*	0.5*	4.0*
1979	3.9*	3.0*	5.2*
1969-79 Mean	6.0*	3.7*	5.7*
1973-79 Mean	5.7*	3.0*	7.1*

* All age classes have not yet returned; return per spawner is minimal.

egg incubation environment than either Upper Russian Lake or the Kenai River spawning and incubation areas. The early run's limited reproductive capabilities are not viewed with concern because the run is exploited only by a strictly regulated sport fishery at Russian River (Nelson, 1984). Late run Russian River production from 1969 through 1972 averaged only 3.3:1 compared to Kenai River production for that same period of 6.4:1. In 1973, Russian River production began to increase. Since that time this run is producing at a slightly higher rate than are Kenai River fish.

Late run Russian River production estimates may now be compared to known spawning escapements in Table 18. In this table, production figures are correlated with escapements which are categorized as "low", "intermediate" or "high."

Fry Rearing Capacity of Upper Russian Lake:

Nelson (1984) concluded that above average late run return per spawner resulted from low parent year escapements and that the converse was also true. This evidence suggested Upper Russian Lake was at or near carrying capacity. The more fry in the lake, the greater the competition for food and space and the lower the production per spawner. This author also indicated that at some unknown high escapement level, the late Russian River run would theoretically fail to reproduce itself.

Data to generate production figures from known escapements in Table 18 were developed by compiling commercial harvest, sport harvest, escapement and numbers of fish by age class produced by a given year class. With the exception of escapement data, these figures are estimates subject to varying degrees of error. A more simplistic approach which reduces the number of variables is to compare known Russian River late run escapements to the estimated total return to Russian River 5 years hence. This comparison is shown in Table 19 and was developed outlining the assumptions of Nelson (1984).

Both Tables 18 and 19 are in basic agreement. An inverse relationship exists between numbers in the spawning escapement and production per spawner. The exception to this generalization resulted from the high escapement in 1979 which returned large numbers of fish in 1984. Nonetheless, it is the opinion of the author that one exception in 17 years does not invalidate the general premise that as escapements increase above an optimal level production per spawner decreases.

Further evidence that the carrying capacity of Upper Russian Lake has been reached or is being approached is indirectly determined by ranking selected sockeye salmon nursery lakes based on adult escapement per km^2 of surface area. This was done by Burgner, et. al. (1969). When Upper Russian Lake is added to the author's list of 10 lakes, it ranks first in terms of escapement per km^2.

Although ranking Upper Russian Lake "Number 1", in terms of escapement per unit of surface area, is not conclusive; it is one more indicator

Table 18. Late run Russian River production per spawner from years of low, intermediate and high escapements, 1969-1979.

Parent Year	Parent Year Escapement	Total Return*	Return/ Spawner
	Low Escapement (<30,000)		
1969	28,920	92,540	3.2
1970	28,200	132,540	4.7
1973	24,970	239,710	9.6
1974	24,650	241,570	9.8
1977	21,410	143,450	6.7**
	Mean	169,960	6.8
	Intermediate Escapement (30,000-50,000)		
1975	31,970	198,210	6.2
1976	31,950	258,800	8.1**
1978	34,230	92,420	2.7**
	Mean	183,140	5.7
	High Escapement (>50,000)		
1971	54,430	125,190	2.3
1972	79,000	244,900	3.1
1979	87,920	457,180	5.2**
	Mean	275,757	3.5

* Commercial harvest, sport harvest and escapement.
** All age classes for these years have not yet returned; return per spawner is therefore minimal.

Table 19. Late run Russian River escapements compared to Russian River return during years of low, intermediate and high escapements.

Parent Year	Parent Year Escapement	Return Year		Return to Russian River	Return/ Spawner
		Low Escapement (<30,000)			
1965	21,820	1970		28,800	1.3
1969	28,920	1974		33,150	1.1
1970	28,200	1975		40,360	1.4
1973	24,970	1978		58,760	2.3
1974	24,650	1979		114,750	4.7
1977	21,410	1982		40,950	1.9
			Mean	52,800	2.1
		Intermediate Escapement (30,000-50,000)			
1964	46,930	1969		30,070	0.6
1966	34,430	1971		65,160	2.0
1967	49,480	1972		95,050	2.0
1968	48,880	1973		33,900	0.7
1975	31,970	1980		117,470	3.7
1976	31,950	1981		68,250	2.1
1978	34,230	1983		47,000	1.4
			Mean	65,270	1.8
		High Escapement (>50,000)			
1963	51,120	1968		54,700	1.1
1971	54,430	1976		42,680	0.8
1972	79,000	1977		48,850	0.6
1979	87,920	1984		114,630	1.3
			Mean	65,215	0.9

which suggests this lake is at or near its production capability. A similar conclusion was reached through analysis of available plankton which is the primary source of food for rearing sockeye salmon.

Plankton in Hidden Lake (a low sockeye salmon producing lake on the Kenai Peninsula) was compared to plankton in Upper Russian Lake. The mean size of two species of plankton in Hidden Lake was larger than the mean size of the same two species in Upper Russian Lake. A zooplankton preferred by sockeye salmon, *Daphnia galeata mendota*, was prevalent in Hidden Lake but absent in Upper Russian Lake. Additionally, Upper Russian Lake sockeye salmon generally rear in freshwater for 2 years as opposed to 1 year in Hidden Lake.

It was concluded that rearing sockeye salmon have completely eliminated *D. galeata mendota* from Upper Russian Lake. The remaining two species are believed cropped to the degree that they never achieve a large mean size. Rearing is generally for 2 years in Upper Russian Lake rather than 1 year due to increased competition among rearing sockeye salmon for available food in Upper Russian Lake (Nelson, 1984).

Evaluation of Escapement Goals:

Three different parameters have been applied to determine early and late run Russian River escapement goals; i.e., historic escapement levels, water quality and available plankton as well as analysis of the late run escapement to return ratio. Results from these approaches are in basic agreement. Combined early and late run escapements should approximate 62,500 fish. Maximum early run reproduction is achieved with escapements between 9,000 and 15,000 fish. To date, returns from escapements in excess of 20,000 early run fish have failed to reproduce themselves. Optimum late run escapement should range from 30,000-50,000 fish with escapements approximating 40,000 being desirable (Nelson, 1984).

All data examined indicate Upper Russian Lake is at or approaching fry-carrying capacity. There is undoubtably intense competition between age classes of early and late run rearing fish for available food and space. Increasing the spawning escapement in Upper Russian Lake will, therefore, not result in increased production per spawner. In fact, available data indicate increased escapements above the optimum level will actually decrease production per spawning fish even though the total return may be above average.

Management Concerns:

Management of the early run poses relatively few problems. The stock is currently at a high level and is harvested only by a restrictive sport fishery. Management of the late run, however, is more complex. This stock is harvested by a highly efficient mixed stock commercial fishery in addition to an intense sport fishery. Overexploitation is an annual possibility.

Nelson (1984) reviewed total late run Russian River production and the contribution of this run to the commercial fishery. He concluded that

whenever this fishery's exploitation rate was 72.2% or greater, it may be necessary to close the Russian River sport fishery to achieve the minimum 30,000 escapement goal. Data from 1984 also support this conclusion.

The 1984 return of Kenai River sockeye salmon was below average (Ken Tarbox, Fishery Biologist, Alaska Department of Fish and Game, Soldotna, Alaska, pers. comm.). Commercial fishing in Cook Inlet was, therefore, restrictive and the seasonal exploitation rate in this fishery was 62.1%, which is below average. The return to Russian River of 114,630 was above average. No closure of the sport fishery was required. The correlation between commercial exploitation rates and emergency closures during the late run Russian River sport fishery is evident (Table 20). The higher the exploitation rate in the commercial fishery, the greater the probability of an emergency closure for stock conservation during the sport fishery.

The increasing efficiency of the Russian River angler also contributes to the probability of emergency closures for stock conservation. In 1975 the mean late run Russian River harvest was approximately 500 fish per day. Due to increased angler effort and a better general knowledge of the fishery, anglers harvested 1,333 fish per day in 1983. In 1984 this decreased to approximately 800 fish daily because of the rapid migrational rate. However, it is not unreasonable to assume a daily harvest rate approaching 1,500 fish could occur in future years under optimum conditions.

Ensuring an adequate return of late run fish to Russian River, which will be sufficient for recreational and escapement needs, becomes even more difficult when the magnitude of the mainstem Kenai River escapement is compared to the Russian River escapement. The Kenai River escapement on the average exceeds Russian River escapement by a factor of 12 (Nelson, 1984).

Assume a Kenai River parent year escapement of 500,000 and a corresponding Russian River minimum escapement of 30,000. Further assume an identical return rate for both systems of 6:1. Return to the Kenai River would be 3,000,000 and to the Russian River 180,000. From the Kenai River return the commercial fishery could harvest 2,500,000, with the remaining 500,000 for escapement--an exploitation rate of 83.3%. At this rate only 30,000 of the original 180,000 Russian River fish would remain to return to Russian River. This would not permit a recreational fishery.

The above scenario has infinite combinations. The conclusion, however, is the same with any reasonable combination applied. As long as production in the Kenai and Russian Rivers is similar and Kenai River escapements remain disproportionately high in relation to Russian River, a high exploitation rate in the commercial fishery will eventuate. This high exploitation rate will not permit sufficient numbers of fish to return to Russian River to satisfy the needs of the recreational fishery and spawning escapement. If the Kenai River produces at a greater rate than the Russian River, the problem becomes more acute.

Table 20. The commercial exploitation rate and its relationship to emergency closures for stock conservation during the late run Russian River sport fishery, 1975-1984.

Year	Total Russian River Production	Late Run Russian River Escapement	Commercial Exploitation Rate	Emergency Closure Required for Stock Conservation
1975	129,770	31,970	72.2	Yes
1976	152,670	31,950	72.6	No
1977	137,600	21,410	67.1	Yes
1978	326,440	34,230	84.6	Yes
1979	238,070	87,920	59.5	No
1980	246,270	83,980	58.5	No
1981	164,850	44,530	63.0	No
1982	206,820	30,630	80.2	Yes
1983	362,320	34,000	86.2	Yes
1984	299,540	92,660	62.1	No

Age Class Composition

Scale samples collected at Lower Russian Lake weir revealed sockeye salmon in their fifth year of life comprised 86.7% of the early run. Four- and 6-year-old fish contributed the remaining 4.8 and 8.5%, respectively. This age structure is atypical, as historically 67.5% of the early run are 6-year fish of age class 2.3. The reason for this departure from the historic age class composition in 1984 is not known. Male to female sex ratio was 1:0.7.

Early run salmon averaged 588 mm (23.1 in) in length. Mean lengths of two- and three-ocean fish were 544 mm (21.4 in) and 591 mm (23.3 in), respectively (Table 21).

The majority of the late run (61.3%) resided 2 years in freshwater and 2 years in the marine environment (69.8%). Male to female sex ratio, excluding jacks, was 1:0.9. Late run sockeye salmon averaged 546 mm (21.5 in) which is 42.0 mm (1.7 in) less than the average early run fish. This length differential between early and late run fish occurs annually and has been discussed (Nelson, 1982). Three-ocean early and late run fish averaged 591 mm (23.3 in) and 585 mm (23.0 in), respectively. Late run fish are generally larger than early run fish of similar ocean age because the late run remains in saltwater approximately 1 month longer than the early run during their final year of life. Age class data for the 1984 early and late runs are summarized in Table 22.

Table 23 summarizes historical early and late run Russian River sockeye salmon age class composition. The dominance of age class 2.3 in the early and 2.2 in the late run is evident. The exception to the dominance of age class 2.3 in the early run occurred in 1977, 1981 and again in 1984. In these years age class 1.3 comprised 46.5 to 86.7% of the return. The reason fish emigrated as 1- rather than 2-year smolts during these years is not known. However, it is assumed that rearing conditions were favorable during these years and sockeye salmon fry experienced accelerated growth. The exception to the dominance of age class 2.2 in the late run occurred in 1983. The reason for this departure from the historic age class composition has been discussed (Nelson, 1984).

Length frequency of 165 early run sockeye salmon is presented in Figure 5. Given the premise that the early and late runs are comprised of two and three-ocean salmon, this figure suggests a division of ocean ages at 589 mm (23.2 in). Calculating the ocean age of early run fish employing this criteria reveals 44.9% of the run would be two-ocean and the remaining 55.1% three-ocean. Scale analysis indicated only 5.4% of the 1984 escapement were two-ocean. Length frequency could, therefore, not be used to separate ocean ages of early run fish in 1984.

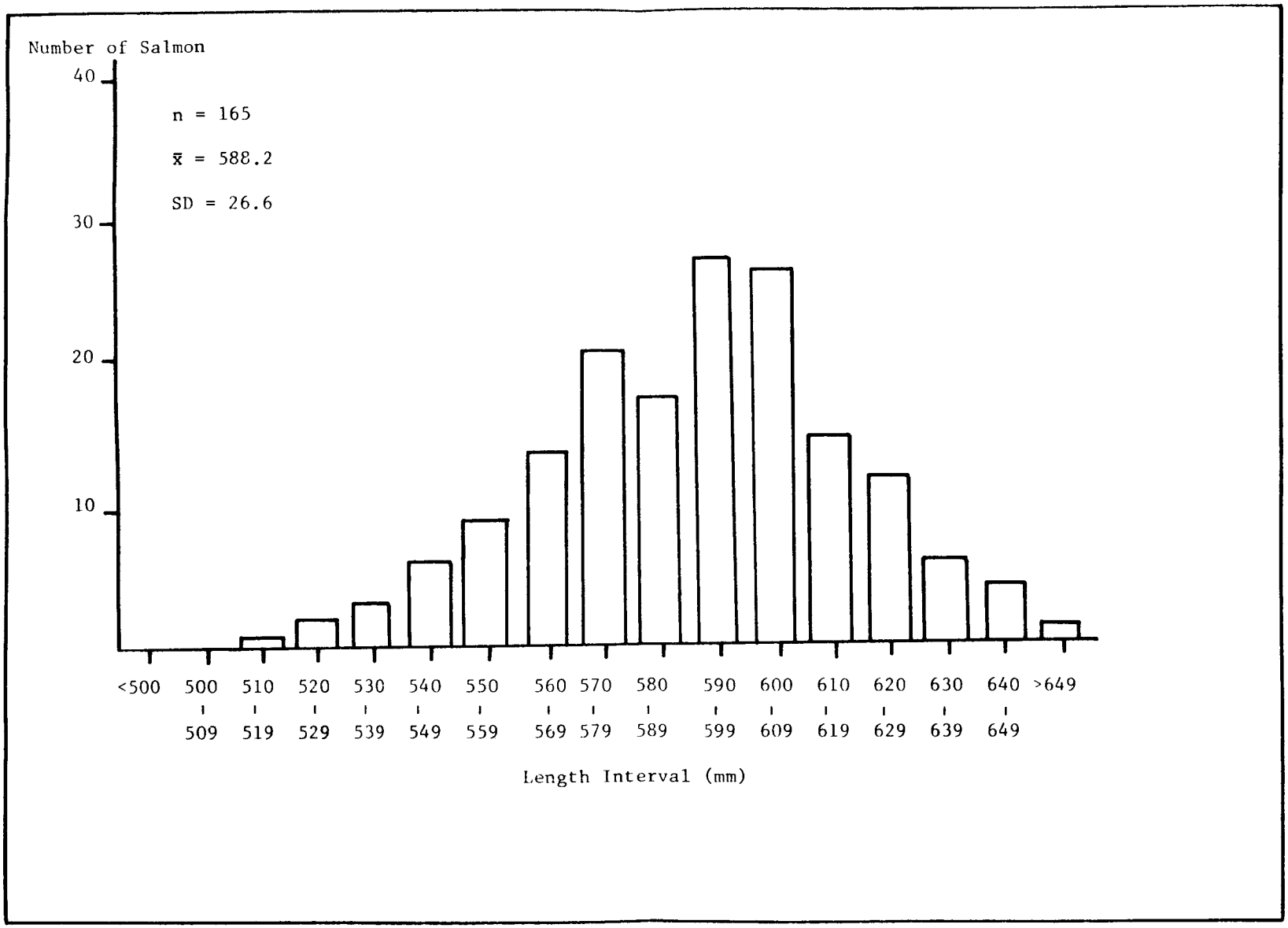

Figure 5. Length frequency of early run Russian River sockeye salmon sampled at Lower Russian Lake weir, 1984.

Table 21. Early and late run Russian River sockeye salmon total returns and mean lengths by ocean-age of fish sampled, 1975-1984.

Year	Total Return**	Mean Length (mm)* Two-Ocean Salmon	Three-Ocean Salmon	Combined
		Early Run		
1975	7,040	542	601	589
1976	18,090	562	609	592
1977	36,470	560	611	598
1978	71,870	552	605	602
1979	28,100	550	611	605
1980	55,890	544	597	596
1981	31,860	550	602	588
1982	90,580	540	590	590
1983	29,560	532	594	586
Mean	41,051	548	602	594
1984	64,790	544	591	588
		Late Run		
1975	40,360	552	603	561
1976	45,650	572	619	585
1977	48,850	554	615	571
1978	58,760	550	603	567
1979	114,750	542	610	548
1980	117,480	544	601	563
1981	68,250	545	609	561
1982	40,950	531	597	560
1983	50,000	532	606	542
Mean	65,005	547	607	562
1984	114,630	526	585	546

* Lengths are from mid-eye to fork of tail.
** Total return is exclusive of late run sockeye salmon spawning below Russian River Falls.

Table 22. Age class composition, sample size, parent year and mean lengths of adult sockeye salmon in respective age classes for early and late run Russian River escapements, 1984.

Age Class	Estimated Number in Escapement	Sample Size	Estimated Percent of Escapement	Parent Year	Mean Length (mm)*	S.D.**
			Early Run			
1.3	25,056	143	86.7	1979	590	25.1
2.3	2,283	13	7.9	1978	597	22.6
1.2	1,387	8	4.8	1980	544	14.1
2.2	174	1	0.6	1979	530	...
Combined	28,900***	165	100.0		588****	26.6****
			Late Run			
2.2	42,018	106	47.1	1979	521	27.9
1.2	20,250	51	22.7	1980	539	30.2
1.3	13,917	35	15.6	1979	596	25.5
2.3	12,668	32	14.2	1978	592	24.5
3.2	357	1	0.4	1978	410	...
Combined	89,210***	225	100.0		546****	42.8****

* Mean lengths are from mid-eye to fork of tail.
** Standard deviation.
*** Excludes 108 and 3,450 jacks in the early and late run, respectively.
**** Mean lengths and standard deviation computed from total sample.

Table 23. Age class composition in percent of early and late run adult Russian River sockeye salmon escapements, 1970-1984.

	Age Class							
Year	1.2	1.3	1.4	2.2	2.3	2.4	3.2	3.3
				Early Run				
1970	0.4			8.9	87.1	3.6		
1971	1.1	3.2		6.4	89.3			
1972	3.0	38.0		8.4	50.0	0.6		
1973*	...	...	...	...	...	...	...	...
1974	0.5	32.0		3.4	63.6	0.5		
1975	0.4	1.8	0.4	19.7	75.1	0.4		
1976	16.8	1.5		11.4	61.1		0.9	1.3
1977	1.9	60.7		14.0	23.4		0.8	8.4
1978	0.9	3.0		1.6	95.3			
1979		4.5		20.9	74.6			
1980	6.2	8.1	0.4	4.3	81.0			
1981	6.3	46.5		18.9	28.3			
1982		1.2		0.4	98.4			
1983	11.2	37.4		2.8	48.1			0.5
Mean	3.7	18.3	0.1	9.3	67.3	0.4	0.1	0.8
1984	4.8	86.7		0.6	7.9			
				Late Run				
1970	2.5	2.9		87.3	7.3			
1971	1.9	5.3		61.5	30.3			
1972*	...	...	...	...	...	...	...	...
1973*	...	...	...	...	...	...	...	...
1974	5.5	9.0		58.6	26.9			
1975	5.4	2.9		65.9	23.9		1.9	
1976	10.9	4.3		59.6	23.6		1.0	0.6
1977	6.6	7.7		72.6	13.1			
1978	0.9	5.3		58.8	35.0			
1979	2.1	0.4		88.2	8.2		0.9	0.2
1980	25.2	7.4		56.6	10.8			
1981	13.8	6.6		60.2	18.9		0.5	
1982	8.8	2.8		46.0	39.2		2.0	1.2
1983	73.7	8.0		12.6	5.7			
Mean	13.1	5.2		60.7	20.3		0.5	0.2
1984	22.7	15.6		47.1	14.2		0.4	

* No samples were collected during the early run in 1973, or during the late run in 1972 and 1973.

Late run length frequency data are also not definitive and no division of ocean age by length is indicated (Figure 6). This figure does show the extreme length differences displayed by individual late run fish in 1984. Lengths ranged from 400 mm (15.7 in) to 649 mm (25.5 in), a difference of more than 249 mm (9.8 in). Lengths of early run fish were more uniform ranging from 510 mm (20.1 in) to 649 mm (25.5 in) a difference of 139 mm (5.5 in).

Early Run Return Per Spawner

Table 24 presents the numbers of fish produced for each early run fish in the parent year spawning escapement. From 1963-1977, the return per spawning fish in the parent year escapement averaged 2.9, ranging from 0.2 to 10.6. The significance of a return of 10.6 for each salmon in the escapement has been discussed (Nelson, 1979). As previously noted in this report, a large spawning escapement does not yield a high production rate. The two highest parent year escapements to date were 21,510 in 1965 and 34,150 in 1978. These high escapements failed to reproduce themselves. Conversely, the return rate of 10.6 originated with a relatively low spawning escapement of 9,270.

Foerster (1968) indicates that irrespective of the level of escapement, fluctuations in the numbers of returning adult fish are quite marked. As an example, he cites the Fraser River return per spawner from 1938 to 1954 which ranged from 2.2 to 13.0, averaging 5.4. The author concludes most of this variability is attributable to environmental conditions during the freshwater developmental stages. This conclusion is believed applicable to the early Russian River sockeye salmon stock, as the spawning area of Upper Russian Creek is not a stable environment. Observation indicates it is subject to flooding, low water, etc., during the spawning and incubation period.

Fecundity Investigations

Fecundity investigations initiated in 1973 were continued during the 1984 season. Data from 1984 early and late run investigations are presented in Tables 25 and 26, respectively.

Early run fish sampled averaged 2.6 kg (5.6 lb) in weight and 580 mm (22.8 in) in length. These fish averaged 1,380 egg/kg of body weight and 6.0 eggs/mm of body length. Mean fecundity of early run fish was 3,505 eggs/female. Average weight and length of late run fish were 2.1 kg (4.5 lb) and 543 mm (21.4 in), respectively. Late run fish averaged 1,308 eggs/kg of body weight and 5.1 eggs/mm of body length. Average fecundity was 2,747 eggs/female. Table 27 compares early and late run fecundity with results from prior years.

Mean fecundity of early run fish sampled in 1984 are within historical ranges. Average weight and length of late run fish were at the lower end of the historic range as was fecundity, eggs/kg and eggs/mm.

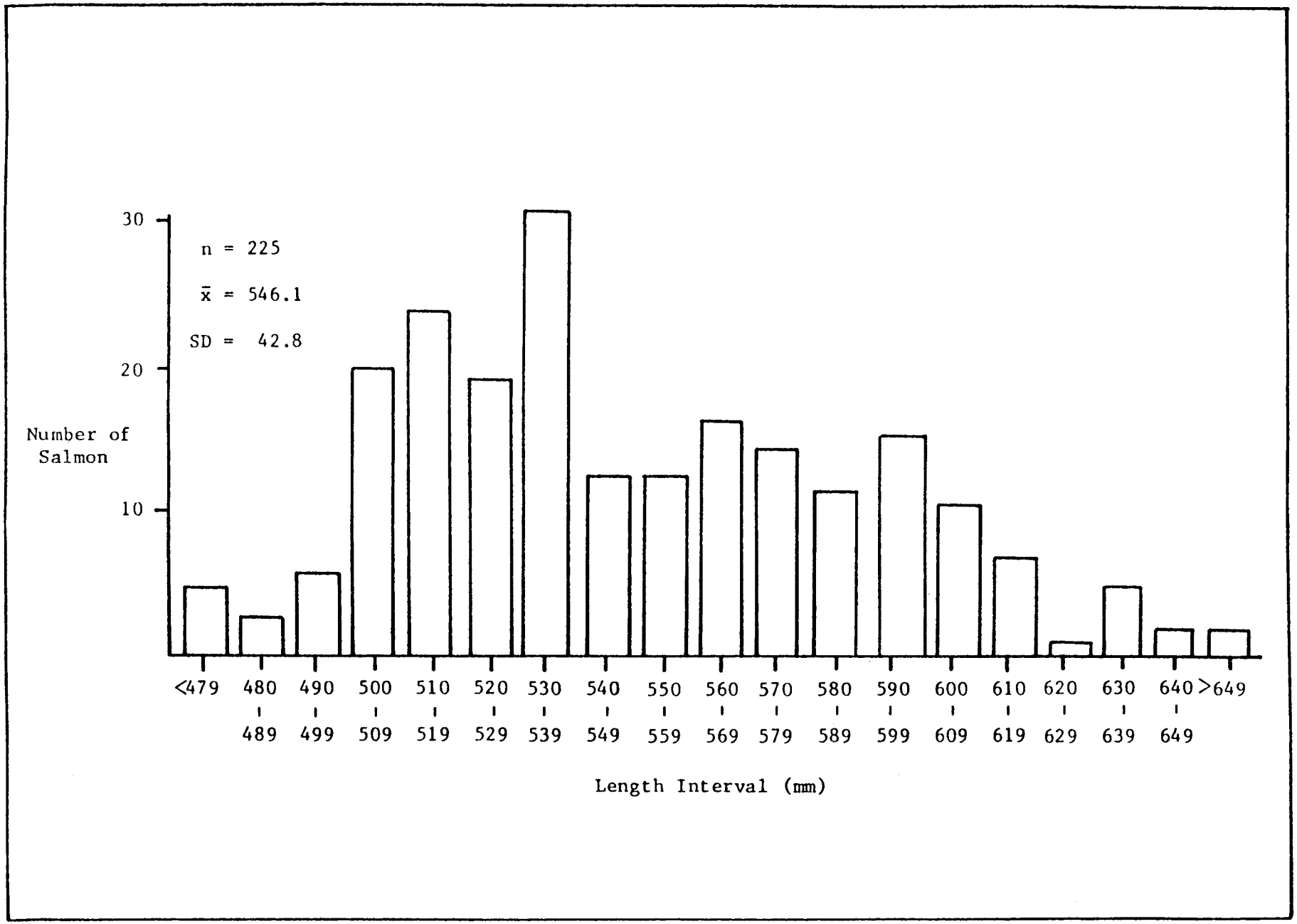

Figure 6. Length frequency of late run Russian River sockeye salmon sampled at Lower Russian Lake weir, 1984.

Table 24. Estimated production from known escapements of early run Russian River sockeye salmon, 1963-1978.

Parent Year	Parent Year Escapement	Total Return (Production)*	Return Per Female	Return Per Spawner
1963	14,580	10,870	1.5**	0.7**
1964	12,700	11,200	1.8**	0.9**
1965	21,510	4,875	0.4**	0.2**
1966	16,660	8,183	1.0	0.5
1967	13,710	19,628	2.8	1.4
1968	9,200	18,946	4.0	2.0
1969	5,000	14,508	5.8	2.9
1970	5,450	12,810	5.3	2.3
1971	2,650	10,896	8.7	4.1
1972	9,270	98,775	26.6	10.6
1973	13,120	24,962	3.8	1.9
1974	13,150	52,704	9.7	4.0
1975	5,640	15,947	4.6	2.8
1976	14,700	113,580	15.5	7.7
1977	16,070	17,674	3.8	1.1
Mean	11,561	29,037	6.3	2.9
1978	34,150	17,001	1.1	0.5

* Total return equals sport harvest plus escapement. A negligible commercial harvest is assumed.

** Assumes a male to female sex ratio of 1:1.0 in the parent year escapement. Sex ratios for succeeding years were determined by sampling.

Table 25. Fecundity of early run Russian River sockeye salmon as determined by sampling at Lower Russian Lake weir, 1984.

Sample Number	Weight kg	Weight lb	Length (mm)	Number of Eggs Right Skein	Number of Eggs Left Skein	Number of Eggs Combined
1	2.3	5.0	565	1,462	1,563	3,025
2	2.6	5.8	585	1,484	1,927	3,411
3	2.2	4.8	560	1,650	1,766	3,416
4	2.5	5.4	600	1,766	2,459	4,225
5	2.8	6.1	610	1,775	1,550	3,325
6	2.5	5.6	555	1,577	2,142	3,719
7	3.3	7.3	625	1,853	2,399	4,252
8	2.5	5.5	500	1,889	1,702	3,591
9	2.4	5.3	570	1,576	1,696	3,272
10	2.6	5.7	600	1,245	1,473	2,718
11	2.8	6.1	610	1,612	2,271	3,883
12	2.3	5.1	575	1,453	1,771	3,224
Mean	2.6	5.6	580	1,612	1,893	3,505

Table 26. Fecundity of late run Russian River sockeye salmon as determined by sampling at Lower Russian Lake weir, 1984.

Sample Number	Weight kg	Weight lb	Length (mm)	Number of Eggs Right Skein	Number of Eggs Left Skein	Number of Eggs Combined
1	2.2	4.8	550	1,665	1,405	3,070
2	2.5	5.4	600	2,098	2,167	4,265
3	2.9	6.4	600	1,437	1,461	2,898
4	1.9	4.1	530	1,069	1,399	2,468
5	1.5	3.3	505	789	952	1,741
6	2.1	4.6	555	1,419	1,237	2,656
7	1.8	3.9	500	1,326	1,291	2,617
8	2.1	4.7	540	1,204	1,597	2,801
9	2.4	5.3	585	1,625	1,808	3,433
10	1.7	3.8	505	1,168	1,447	2,615
11	1.4	3.0	490	602	862	1,464
12	2.2	4.9	555	1,515	1,418	2,933
Mean	2.1	4.5	543	1,326	1,420	2,747

Table 27. A comparison of fecundity data collected at Lower Russian Lake weir during early and late run Russian River sockeye salmon migrations, 1973-1984.

Year	Mean Fecundity	Mean Length (mm)	Mean Weight (kg)	Eggs/ Kilogram	Eggs/ Millimeter
		Early Run			
1973	4,630	627	2.97	1,559	7.4
1974	3,569	603	2.60	1,373	5.9
1975	3,952	600	2.54	1,556	6.6
1976	3,668	596	2.61	1,405	6.1
1977	4,313	603	2.85	1,513	7.1
1978	3,815	608	2.82	1,353	6.3
1979	3,842	577	2.49	1,543	6.7
1980	3,534	573	2.42	1,460	6.2
1981	3,412	570	2.32	1,471	6.0
1982	3,479*	588	2.64	1,318	5.9
1983	3,063	548	2.22	1,380	5.6
Mean	3,752	590	2.59	1,448	6.3
1984	3,505	580	2.54	1,380	6.0
		Late Run			
1973	3,190	569	2.19	1,457	5.6
1974	3,261	558	2.30	1,418	5.8
1975	3,555	555	2.26	1,573	6.4
1976	3,491	587	2.53	1,380	5.9
1977	3,302	567	2.44	1,353	5.8
1978	2,865	584	2.67	1,073	4.9
1979	3,314	542	2.20	1,506	6.1
1980	2,740	544	1.98	1,384	5.0
1981	3,268	552	2.15	1,520	5.9
1982	3,702	593	2.72	1,361	6.2
1983	2,593	548	2.22	1,168	4.7
Mean	3,207	564	2.33	1,381	5.7
1984	2,747	543	2.10	1,308	5.1

* Fecundity calculated by linear regression. Correlation coefficient between length (x) and fecundity (y) equals 0.75.

Egg Deposition

Assuming the mean fecundity of early run fish is representative of early run stocks, the potential number of eggs available for deposition in Upper Russian Creek may be calculated. Losses between weir and spawning grounds, females which perish without spawning and numbers of eggs retained per spent female must also be considered. Nelson (1976) has presented a detailed discussion of these criteria and the methodology employed to calculate potential early run egg deposition. Deposition in 1984 was estimated at 41.7 million (Table 28).

As would be expected, Table 28 reveals that the greater the spawning escapement the greater the potential egg deposition. However, some variability in reproductive potential will occur annually irrespective of the number of salmon in the spawning escapement in that mean fecundity and the male to female sex ratio are not constant (Hartman and Conkle, 1960). It should also be noted that neither a definitive nor direct relationship is evident between numbers in the spawning escapement, potential eggs available for deposition and adult return. Factors other than eggs available for deposition, therefore, exert a significant influence on the adult return of early run sockeye salmon. These variables are believed to be present primarily during freshwater residency and are environmentally related (Foerster, 1968).

It was previously believed that hydraulic egg sampling would permit an evaluation of spawning success (number of eggs deposited) as this success was related to environmental parameters present during spawning and early portion of the egg incubation period. It was further assumed a direct relationship existed between egg density and the return of adult early run fish 6 years hence. Analysis revealed this assumption was not valid. It was concluded there was no discernible relationship between eggs in the gravel at time of sampling and subsequent adult return (Nelson, 1983).

Returns of early run Russian River sockeye salmon are apparently subject to factors other than or in addition to egg density; i.e., carrying capacity of Upper Russian Lake, predation during freshwater residency, relationship of early run rearing fish to late run rearing fish, annual variation in marine survival, etc. Until these parameters are identified, there is no value in determining actual early run egg deposition in Upper Russian Creek.

Climatological Observations

Climatological data recorded at Lower Russian Lake weir were grouped by 6-day periods to facilitate analysis (Table 29). No correlation was evident between air and water temperature and sockeye salmon migration. Temperatures were comparable to prior years. Total precipitation between June 7 and September 10 was 155.5 mm (6.1 in). Fifty-five percent of this total was recorded after August 23, which contributed to above average flow rates during the latter segment of the late run migration. Flows during this time remained below 400 cfs and sockeye salmon had no difficulty negotiating Russian River Falls in 1984.

Table 28. Potential egg deposition from early run sockeye salmon escapement in Upper Russian Creek and known adult returns produced from a given number of eggs deposited, 1972-1984.

Year	Escapement	Potential Egg Deposition (millions)	Adult Return
1972	9,270	15.0	98,773
1973	13,120	29.6	24,962
1974	13,150	17.7	52,704
1975	5,640	12.7	15,947
1976	14,700	23.5	113,580
1977	16,070	18.2	17,674
1978	34,150	62.8	17,001
1979	19,700	30.9	
1980	28,670	44.2	
1981	21,140	32.0	
1982	56,080	89.7	
1983	21,200	28.3	
1984	28,910	41.7	

Table 29. Climatological and hydrological observations by six-day periods recorded at Lower Russian Lake weir, June 7 through September 10, 1984.

Period	Water Temp.* Max°C	Water Temp.* Min°C	Air Temp.* Max°C	Air Temp.* Min°C	Rainfall (mm)**	Russian R. Discharge* (cfs)	Rondezvous Ck. Discharge* (cfs)	Total Discharge* (cfs)
June 07-12	11.7	10.1	21.4	6.1	2.3	314.2	25.3	339.5
June 13-18	12.5	10.1	17.0	6.4	12.1	232.4	39.7	272.1
June 19-24	15.0	11.5	23.3	7.4	0.0	244.4	65.9	310.3
June 25-30	13.3	11.3	17.4	9.8	0.0	273.9	87.5	361.4
July 01-06	13.7	11.4	20.0	8.4	3.0	207.0	87.9	294.9
July 07-12	14.8	12.7	18.0	9.2	26.9	229.7	84.2	313.9
July 13-18	14.2	12.0	17.5	9.7	5.4	168.2	47.2	215.4
July 19-24	14.4	11.7	17.7	8.9	0.9	164.3	54.4	218.7
July 25-30	14.6	12.9	17.5	9.3	6.8	150.2	55.7	205.9
July 31-Aug. 5	15.9	13.0	20.2	11.1	2.5	140.6	42.3	182.9
Aug. 6-11	17.6	14.7	21.0	10.8	10.0	133.3	39.7	173.0
Aug. 12-17	17.6	14.2	20.2	6.1	0.1	117.7	31.4	149.1
Aug. 18-23	14.8	11.9	14.0	9.5	60.9	222.0	37.7	259.7
Aug. 24-29	11.8	11.3	12.6	4.1	24.4	213.6	52.2	265.8
Aug. 30-Sept. 4	10.5	10.4	12.9	0.9	0.2	127.8	37.7	165.5
Sept. 5-10	10.4	10.4	13.9	2.0	0.0	113.5	30.0	143.5

* Air temperature, water temperature and discharge for the respective periods are the means of the daily recordings.

** Rainfall for each period is the cumulative total of the daily recordings.

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